

IMPERX



Cheetah Pregius Cameras User Manual 10 GigE Vision Interface with SFP+

The Imperx Cheetah CMOS cameras provide exceptional video image quality in a remarkably compact and ruggedized design with resolutions of 17, 20 and 31 MP. The cameras use Sony 3rd generation Pregius CMOS sensors for their high sensitivity, image clarity, and high dynamic range. They achieve frame rates up to 56.5 frames per second with 10 GigE Vision interface. An SFP+ connector is provided to mate with various transceiver modules

Revision 1.1

About Imperx, Inc.

IMPERX, Inc. is a leading designer and manufacturer of high performance, high quality digital cameras, frame grabbers, and accessories for industrial, commercial, military, and aerospace imaging applications including flat panel inspection, biometrics, aerial mapping, surveillance, traffic management, semiconductors and electronics, scientific & medical Imaging, printing, homeland security, space exploration, and other imaging and machine vision applications.

Fortune 100 companies, federal and state government agencies, domestic and foreign defense agencies, academic institutions, and other customers worldwide use IMPERX products.

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Warranty

IMPERX warrants performance of its products and related software to the specifications applicable at the time of sale in accordance with IMPERX's standard warranty, which is 2 (two) years parts and labor.

Do not open the housing of the camera. Warranty voids if the housing has been open or tampered.

IMPORTANT NOTICE

This camera has been tested and complies with the limits of Class A digital device, pursuant to part 15 of the FCC rules.

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REVISION HISTORY

Revision	Date	Reviser	Comments
0.1	08/12/2020	I. Barabanova	Preliminary version
1.0	10/08/2020	I. Barabanova	Initial release
1.1	5/6/2021	I. Barabanova	Adjusted Frame Rates Added UKCA compliance Changed GevSCPSPacketSize maximum value to 8164 Changed Operating Temperature Range Added description for the IpxPlayer panels: Histogram, Camera Terminal, HexPixelDump Added <i>Saving Image in AVI Movie File Format</i> section Added new Power Supply (PS12V14A) Changed Strobe Min/Max Width and Delay Updated Canon Lens Control specifications Added Focus and Iris adjustment procedures for a Canon Lens

TERMINOLOGY

Defective pixels – these are pixels whose sensitivity deviates due to fluctuations in the CMOS manufacturing process and materials.

Fast trigger mode – a camera exposes a frame and then exposes the next frame while reading out the previous frame. In this way, the camera overlaps the exposure and readout times. Fast trigger mode requires a predictable and stable trigger period. The *TriggerOverlap* setting is On.

Free-running mode – a camera runs without synchronization to an external trigger pulse (untriggered mode).

Hot pixels – these are pixels that in normal camera operation behave as normal pixels (sensitivity equal to one of the adjacent pixels). But during long exposures or at elevated temperatures, the pixel becomes far brighter than the average of the pixels surrounding it. In some cases, the pixel becomes so bright that it saturates.

Standard trigger mode – a camera waits for a trigger pulse, then exposes using an internal exposure timer and reads out a frame and waits for next trigger pulse. The exposure and readout do not overlap. The *TriggerOverlap* setting is Off.

Trigger mode – a camera waits for a trigger pulse to start the image capture, synchronizing it to either an internal or external event.

AEC – Automatic exposure control

AGC – Automatic gain control

AOI – Area of interest

AWB – Automatic white balance

DPC – Defective pixel correction

FFC – Flat field correction

HPC – Hot pixel correction

LUT – Look-up table

SFP – Small Form-factor Pluggable

About the Camera

General

The 10 GigE Vision SFP+ Cheetah CMOS cameras are built around advanced Sony Pregius CMOS image sensors with global shutter for high quality images in a small ruggedized form factor. Cheetah cameras are progressive scan digital cameras featuring a built-in image-processing engine, low power consumption, low noise, high dynamic range (71 dB), and fast frame rates for high throughput applications.

The cameras provide several trigger modes and output strobes allowing you to synchronize the image capture of one or more cameras to an external event. You can vary exposure times using internal controls or an external pulse width.

The cameras also provide an area of interest (AOI), programmable look-up tables (LUT) and the ability to store up to four different camera configurations. Using the simple GenICam™ compliant user interface, you can quickly change the camera configuration. User-defined LUT capabilities optimize the cameras' dynamic range. Hot and defective pixel correction is available to correct over-responding or under-responding pixels.

The cameras are suitable for a wide range of environmental conditions and applications, such as machine vision, industrial inspection, surveillance, aerospace, and more.

The C5440, C4440, and C6440 cameras feature 17 MP, 20 MP, and 31 MP Sony Pregius CMOS sensors respectively, provide support for active Canon EOS lens with iris and focus controls.

Camera Model	Resolution (MP)	Resolution (H x V)	Frame Rate (Max)	Type (Color/Mono)	Optical format	Pixel Size (microns)	Sony Sensor Model
SFP-C5440	17	5472 x 3084	56.5	C, M	4/3"	3.45	IMX387
SFP-C4440	20	4416 x 4436	39.6	C, M	4/3"	3.45	IMX367
SFP-C6440	31	6464 x 4860	35.4	C, M	APS-C	3.45	IMX342

Key Features

- Global shutter (GS)
- Color and monochrome versions
- Fast frame rates
- High data transfer rates up to 10 Gbit/s
- Internal and external exposure controls
- Automatic exposure and gain control (AEC/AGC)
- Analog and digital gain control
- Offset control
- Built-in pulse generator
- Area of interest (AOI)
- Programmable external inputs and outputs
- Multiple Trigger/Synchronization options
- Automatic white balance
- Four 12-bit look-up tables (LUT)
- Hot and defective pixel correction, user-defined and factory
- Eight flat field correction tables, user-defined and factory
- Dynamic transfer function
- Canon EOS EF lens control
- Forced air cooling
- Temperature monitor
- Field upgradeable firmware

Technical Specifications

SFP-C5440 Camera Specifications

Specifications	SFP-C5440 (17 MP)	
Active image resolution	5472 (H) x 3084 (V)	
Pixel size	3.45 μm	
Optical format	4/3 inch	
Shutter	Global	
Frame rate (max)	56.5 fps (8-bit), 34.7 (10, 12-bit unpacked), 40.4 (10, 12-bit packed)	
Sensor digitization	10 or 12-bit	
Dynamic range	71 dB	
Output bit depth	8, 10, or 12-bit	
Shutter speed	36 μs to 16.0 s	
Analog / Digital gain	Manual, auto, once; 0–48 dB (0.1 dB step)	
Digital gain	1x (0 dB) to 4x (12 dB), 0.001x step	
AEC/AGC	Off, once, auto	
Black level offset	Manual (0–4095), auto	
Exposure control	Manual, auto, once, external, off	
White balance	Manual, auto, once, off	
Area of Interest (AOI)	One	
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)	
Sub-sampling decimation	1x2, 2x1, 2x2	
Trigger inputs	External, pulse generator, software	
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce	
Trigger modes	Free-run, standard, fast	
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)	
Strobe output	2 strobes, programmable position and duration	
Pulse generator	Yes, programmable	
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables	
Lens mount	F-mount (default), Canon EOS active or passive, M42 (optional)	
Camera housing	6000 series aluminum	
Upgradeable firmware	Yes	
Forced Air Cooling Control	On, off, auto	
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V	
Power consumption	Typ.: 14.4 W; Max.: 16.8 W	
Camera size (W x H x L)	60 mm x 60 mm x 99 mm	
Weight	530 g	
Vibration, shock	20G (20–200 Hz XYZ) / 100G	
Environmental	Operating	-30 °C to +70 °C (with a fiber 10GBase-R transceiver module); (may vary depending on the transceiver module used);
	Storage	-30 °C to +45 °C (with a copper 10GBase-T transceiver module) -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing	
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA	

SFP-C4440 Camera Specifications

Specifications	SFP-C4440 (20 MP)	
Active image resolution	4416 (H) x 4436 (V)	
Pixel size	3.45 μm	
Optical format	4/3 inch	
Shutter	Global	
Frame rate (max)	39.6 fps (8-bit), 28.3 (10, 12-bit unpacked), 28.3 (10, 12-bit packed)	
Sensor digitization	10 or 12-bit	
Dynamic range	71 dB	
Output bit depth	8, 10, or 12-bit	
Shutter speed	36 μs to 16.0 s	
Analog / Digital gain	Manual, auto, once; 0–48 dB (0.1 dB step)	
Digital gain	1x (0 dB) to 4x (12 dB), 0.001x step	
AEC/AGC	Off, once, auto	
Black level offset	Manual (0–4095), auto	
Exposure control	Manual, auto, once, external, off	
White balance	Manual, auto, once, off	
Area of Interest (AOI)	One	
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)	
Sub-sampling decimation	1x2, 2x1, 2x2	
Trigger inputs	External, pulse generator, software	
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce	
Trigger modes	Free-run, standard, fast	
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)	
Strobe output	2 strobes, programmable position and duration	
Pulse generator	Yes, programmable	
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables	
Lens mount	F-mount (default), Canon EOS active or passive, M42 (optional)	
Camera housing	6000 series aluminum	
Upgradeable firmware	Yes	
Forced Air Cooling Control	On, off, auto	
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V	
Power consumption	Typ.: 14.4 W ; Max.: 16.8 W	
Camera size (W x H x L)	60 mm x 60 mm x 99 mm	
Weight	530 g	
Vibration, shock	20G (20–200 Hz XYZ) / 100G	
Environmental	Operating	-30 °C to +70 °C (with a fiber 10GBase-R transceiver module); (may vary depending on the transceiver module used);
	Storage	-30 °C to +45 °C (with a copper 10GBase-T transceiver module) -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing	
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA	

SFP-C6440 Camera Specifications

Specifications	SFP-C6440 (31 MP)	
Active image resolution	6464 (H) x 4860 (V)	
Pixel size	3.45 μm	
Optical format	APS-C	
Shutter	Global	
Frame rate (max)	35.4 fps (8-bit), 25.8 fps (10, 12-bit packed)	
Sensor digitization	10 or 12-bit	
Dynamic range	71 dB	
Output bit depth	8, 10, or 12-bit	
Shutter speed	36 μs to 16.0 s	
Analog / Digital gain	Manual, auto, once; 0–48 dB (0.1 dB step)	
Digital gain	1x (0 dB) to 4x (12 dB), 0.001x step	
AEC/AGC	Off, once, auto	
Black level offset	Manual (0–4095), auto	
Exposure control	Manual, auto, once, external, off	
White balance	Manual, auto, once, off	
Area of Interest (AOI)	One	
Binning	1x2, 2x1, 2x2 (available only for monochrome sensors)	
Sub-sampling decimation	1x2, 2x1, 2x2	
Trigger Inputs	External, pulse generator, software	
Trigger options	Edge, pulse width, trigger filter, trigger delay, debounce	
Trigger modes	Free-run, standard, fast	
I/O control	2 IN (OPTO, LVTTTL) / 2 OUT (OPTO, TTL)	
Strobe output	2 strobes, programmable position and duration	
Pulse generator	Yes, programmable	
Data correction	2 LUTs pre-programmed with Gamma 0.45, 2 LUTs pre-programmed with Negative LUT; Hot and Defective pixel correction (static); 8 Flat field correction tables	
Lens mount	F-mount (default), Active or passive Canon EOS, M42 (optional)	
Camera housing	6000 series aluminum	
Upgradeable firmware	Yes	
Forced Air Cooling Control	On, off, auto	
Supply voltage range	12 VDC (6.5 V–33 V), 2 A inrush @ 12 V	
Power consumption	Typ. : 14.4 W; Max. : 16.8 W	
Camera size (W x H x L)	60 mm x 60 mm x 99 mm	
Weight	530 g	
Vibration, shock	20G (20–200 Hz XYZ) / 100G	
Environmental	Operating	-30 °C to +70 °C (with a fiber 10GBase-R transceiver module); (may vary depending on the transceiver module used)
	Storage	-30 °C to +45 °C (with a copper 10GBase-T transceiver module); -40 °C to +85 °C
Relative humidity	10% to 90% non-condensing	
Regulatory	FCC part 15 Class A, CE, RoHS, UKCA	

Ordering Information

When ordering a camera, please specify the camera ordering code. To create your own customer Cheetah ordering code, simply choose one element from each column:

Interface	Camera model	Sensor Type	Ruggedized	Lens Mount	Filter/customization options
SFP = 10 GigE Vision with SFP+ connector	C5440 – 5472 x 3084 C4440 – 4416 x 4436 C6440 – 6464 x 4860	C = Color M = Monochrome	R= Ruggedized	F= F-Mount M = M42 L= Canon EF EOS Active Mount E = Canon EF EOS Passive Mount	000 = none

- **000 (none)** filter/customization option means that a color camera has an IR-cut filter, while a monochrome camera does not have any filters.
- Sample codes:
SFP-C6440M-RF000: Cheetah Monochrome 31 MP camera with F-Mount and 10 GigE Vision with SFP+ connector.
SFP-C5440C-RL000: Cheetah Color 17 MP camera with Canon EF EOS Active Mount and 10 GigE Vision with SFP+ connector
- An external power supply is required.
- The Imperx PS12V04A power supply is available for use with SFP cameras and can be purchased separately.

Accessories

Imperx offers a power supply for use with the cameras. The power supply is sold separately.

Part Number	Description	Compatible with:
PS12V14A	Standard Power Supply 12 V DC, 3 A, With one strobe and one trigger, 1.75 m length	SFP-C4440 SFP-C5440 SFP-C6440

Technical Support

Each camera is fully tested before shipping. If, for some reason, the camera is not operational after power up, check the following:

1. Check the power supply, Ethernet, and all I/O cables.
Make sure that all the connectors are firmly attached.
2. Check the status LED and verify that it is steady ON, if not – refer to the section [Camera LED Status Indicator](#).
3. Enable the test mode and verify that the communication between a computer and the camera is established.
If the test pattern is not present, power off the camera, check all the cabling, frame grabber settings, and computer status.

If you still have problems with the camera operation, contact technical support at:

Email: support@imperx.com

Toll Free 1 (866) 849-1662 or (+1) 561-989-0006

Fax: (+1) 561-989-0045

Visit our website: www.imperx.com

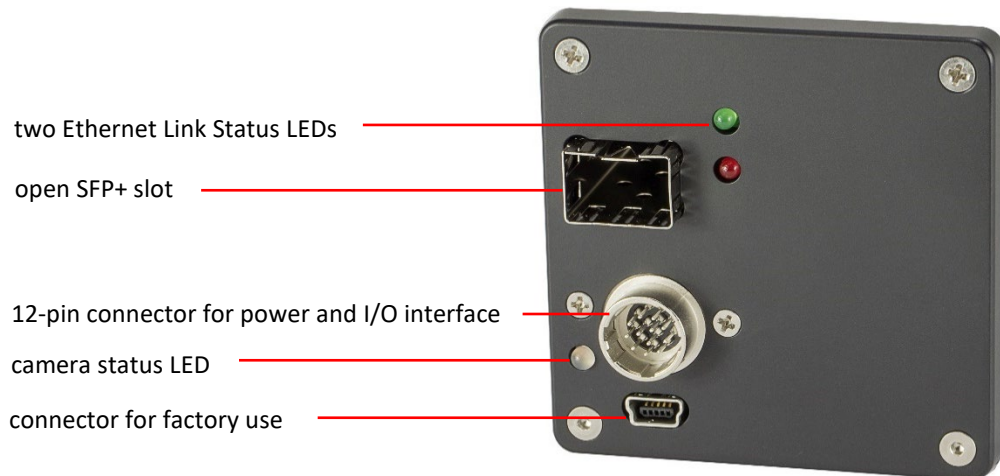
Hardware

This chapter contains the detailed information needed for the initial design-in process:

- connector types, pin numbering and assignments
- electrical connectivity and voltage requirements
- mechanical drawings and cabling
- optical and environmental information

C4440, C5440, C6440 Cameras Connectivity

The back panel of the camera provides all the connectors needed to operate and control the camera and an LED status indicator.



The camera provides the following connectors:

- an open SFP+ slot providing data, control, and serial interface. The SFP+ slot accepts a variety of transceiver modules, including Fiber 10GBase-R and copper 10GBase-T.
- male 12-pin Hirose miniature locking receptacle #HR10A-10R-12PB(71) providing power input and I/O interface. Use a female Hirose miniature locking plug #HR10A-10P-12S(73) on the mating end of your I/O cable
- a camera status LED indicator
- USB type B programming/SPI connector for factory use only
- the camera's model and serial number

The camera transmits serialized video data output and communications over the 10 Gigabit Ethernet interface with consistently low, predictable latencies. The network interface is compatible with IP/Ethernet networks operating at 10 gigabits per second.

SFP Transceiver Module Options

The camera’s open SFP+ slot accepts a variety of commercially available SFP transceiver modules, including Multi-mode and single mode fiber and 10GBase-T copper modules.

SFP transceiver module	SFP transceiver module part number	Cable length	Compatible SFP+ NIC (example)
10GBase-R fiber module	FS SFP-10GSR-85 (10G SFP+ 850 nm)	300 m	Intel 82599EN Single-Port 10G SFP+ PCIe 2.0 x8
10GBase-T copper module	Cisco SFP-10G-T-S Compatible	30 m	Intel X540-T1 10Gb, Intel X550-T1 10Gb, 10Gtek 10Gb PCI-E

10GBase-SR Multi-Mode Fiber Example

Below is an example of a 10GBase-SR SFP+ 850 nm Multi-mode Fiber Transceiver module (p/# FS SFP-10GSR-85) with 300 m range compatible with the Imperx SFP camera.



For optimal performance, Imperx recommends a 10G Network Interface Card with SFP+ slot. Imperx has tested and recommends the Intel 82599EN Single-Port 10G SFP+ PCIe 2.0 x8, Ethernet Network Interface card shown below.

Available for purchase; contact Imperx sales: sales@imperx.com or +1-561-989-0006.



For a multi-mode fiber optic connection, both the Imperx SFP camera and the NIC card must have a 10GBase-SR SFP+ Multi-mode Fiber Transceiver installed like the one shown above.

10GBase-T Copper Example

Below is an example of a Cisco SFP-10G-T-S Compatible, 10GBase-T SFP+ Copper Transceiver with RJ-45 connector.



Imperx recommends an Intel X540-T1 or X550-T1 10Gb NIC card or equivalent. For example, the 10Gb PCI-E NIC Card with single copper RJ45 Port from 10Gtek as shown below.

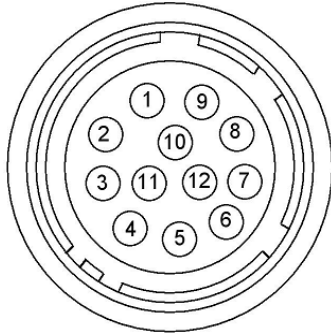


After installation of the 10GBase-T SFP+ Copper Transceiver, the SFP camera can be connected to any 10GigE compatible NIC or Server using standard LAN CAT-5 (CAT-5e) or CAT-6 cables. Shielded cables are recommended. The cable length can vary based on the SFP+ module transceiver. For example, the above transceiver is suitable for distances up to 30 m.

To help clients achieve first iteration success, Imperx offers a variety of transceiver modules and a 10G SFP+ NIC card for sale which have been tested together. Contact Imperx sales department for more information: sales@imperx.com or +1-561-989-0006.

Pin Assignments






The 12-pin Hirose connector on the camera's back panel is a male type miniature locking receptacle #HR10A-10R-12PB(71).



Pin	Signal Name	Use
1	12/24 VDC Return	12 or 24 VDC Main Power Return
2	+12/24 VDC	12 or 24 VDC Main Power
3	Reserved	Reserved
4	Reserved	Reserved
5	OUT2 RTN	General Purpose Output 2, Contact 1 (Opto-isolated)
6	OUT1 RTN	General Purpose Output 1 Return (TTL)
7	OUT1	General Purpose Output 1 (TTL)
8	INPUT1	General Purpose Input 1 (Opto-isolated)
9	INPUT2	General Purpose Input 2 (TTL/LVTTL)
10	INPUT1 RTN	General Purpose Input 1 Return (Opto-isolated)
11	INPUT2 RTN	General Purpose Input 2 Return (TTL/LVTTL)
12	OUT2	General Purpose Output 2, Contact 2 (Opto-isolated)

Camera LED Status Indicator

The camera has a red-green-yellow LED on the back panel of the camera. The following LED colors and light patterns indicate the camera status and mode of operation:

LED Color	Light Patterns	Status Description
	Green steady ON	Normal operation. You should see a normal image coming out of the camera
	Green blinking	Trigger enabled
	Amber steady ON	Test mode. You should see one of the test patterns.
	Amber blinks at ~0.5 Hz	Camera is in AGC/AEC mode. In this mode, changing the shutter slider does not affect image luminance
	Amber blinks at ~2.0 Hz	Camera receives an external synchronization pulse
	Red steady ON	Communications or firmware load error
	Red blinks at ~2.0 Hz	Power failure
	Green / Red blinks at ~1 Hz	GigE Vision firmware error
	LED Off	No power

Ethernet LED Status Indicators

Two LEDs on the camera’s back panel indicate Ethernet status.

Ethernet Status	Amber LED	Green LED
10 Gbps Link – No Activity	Off	Solid On
10 Gbps Link – Activity	Off	Blinks
5 Gbps Link – No Activity	Solid On	Solid On
5 Gbps Link – Activity	Blinks	Blinks
2.5 Gbps Link – No Activity	Solid On	Off
2.5 Gbps Link – Activity	Blinks	Off
1 Gbps Link – No Activity	Blinks	Off
1 Gbps Link – Activity	Blinks	Off
100 Mbps Link – Activity	Off	Blinks at 1Hz
100 Mbps Link – No Activity	Off	Blinks at 1Hz
10 Mbps Link – Activity	Blinks at 1Hz	Off
10 Mbps Link – No Activity	Blinks at 1Hz	Off

Powering the Camera



The maximum supply voltage **must not** exceed 33 V DC.

Plug in the SFP module prior to powering the camera.

Use an external power supply to power the camera.

The external power supply should provide 6.5 V – 33 V DC with the inrush current 2 A @ 12 V. The power supply should terminate in a female HIROSE plug #HR10A-10P-12S(73).

Imperx offers the PS12V14A Standard Power Supply adapter for use with the cameras. The PS12V14A power supply can be purchased separately. It ships with a power cable that terminates in a female HIROSE plug #HR10A-10P-12S(73). The PS12V14A includes connectors for trigger (black wire) and strobe (white wire). Refer to the section [PS12V14A Standard Power Supply](#) for more information.

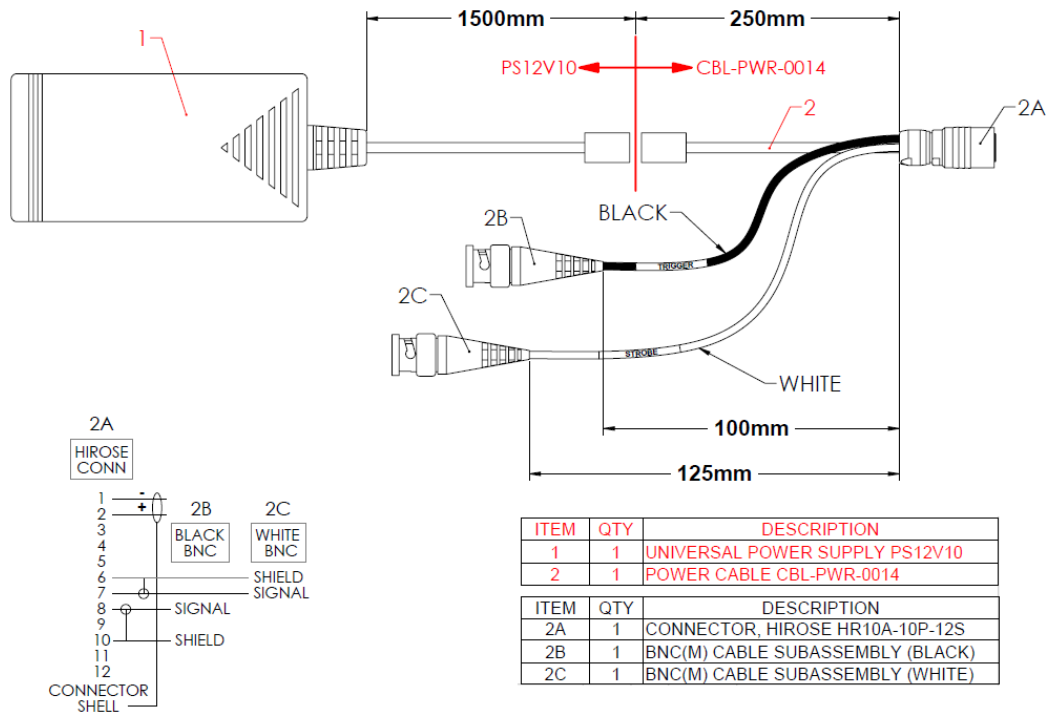
PS12V14A Standard Power Supply

A universal PS12V14A power adapter provides +12 V DC \pm 5% and up to 3 A DC current. The operating input voltage range is 100 to 240 V AC.

The PS12V14A power supply terminates in a female Hirose type miniature locking plug #HR10A-10P-12S(73). It has two BNC pig-tail cables providing external trigger input (black) and strobe output (white)

CAUTION

Imperx recommends using the PS12V14A power adapter for powering C4440, C5440, and C6440 cameras.



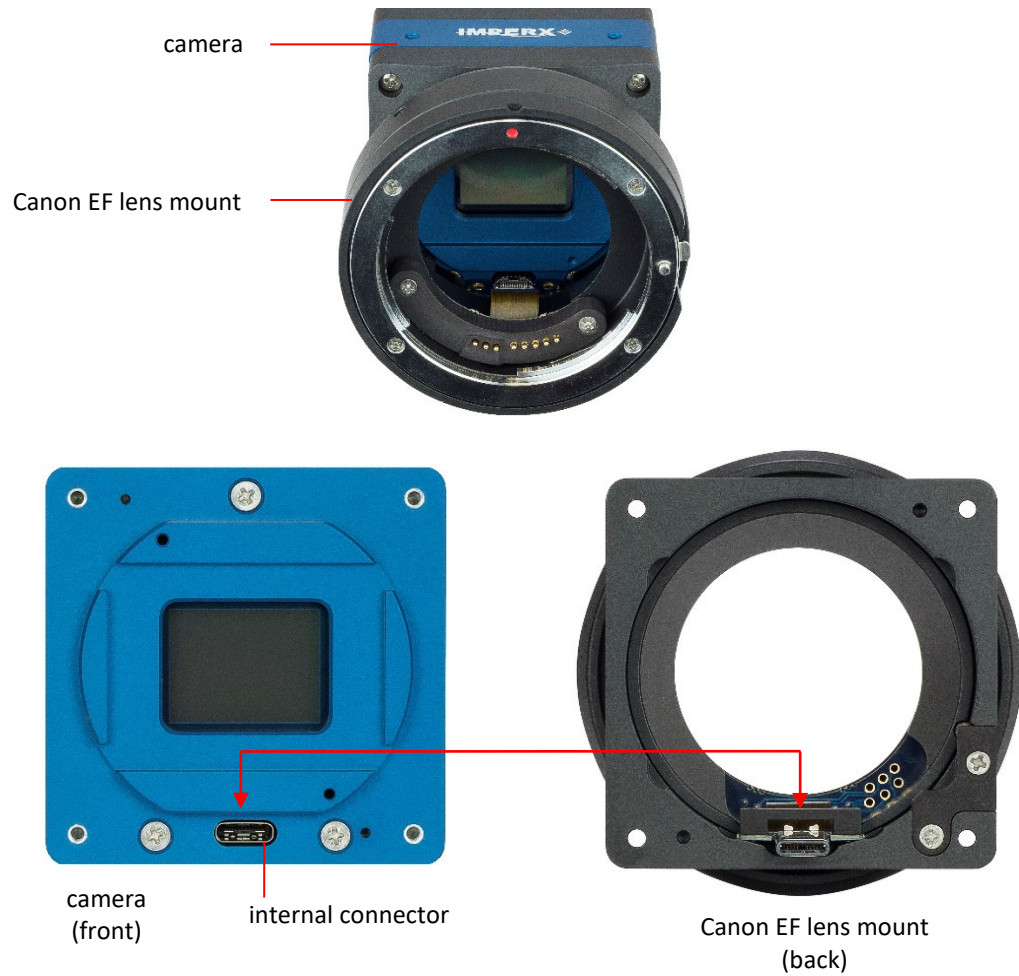
PS12V14A Power Supply Specifications

Specifications		Description
Input		
Voltage		100–240 V AC
Frequency		50–60 Hz
Current		1 A max
Inrush Current		70 A max / 230 V AC (cold start @ 25 °C, full load)
Efficiency		Eff (av) ≥ 87.4 % (at 115 V AC & 230 V AC) Eff ≥ 78.303 % (at 230V/50Hz input @10% load for CoC Tier2)
Output		
Voltage		11.4 V to 12.6 V DC, 12 V DC nominal
Current		3 A max
Load Regulation		± 5%
Ripple & Noise		1% Vpp max for Output Voltage @ full load
Total Power		36.0 W Max
Protection		
Over-Voltage Protective (OVP)		V out * 180% (max)
Short-Circuit Protective (SCP)		Automatic recovery after short circuit fault being removed
Over Current Protection (OCP)		I out * 200% (max)
Safety, EMI and EMC Requirement		
Safety		UL, CUL, GS, PSE, BSMI, CB, RCM, CCC, KC, LPS
Dielectric Strength		10 mA max. cut off current (1) Primary to Secondary: 3000 V AC for 1 minute (2) Primary to Frame Ground: 1500 V AC for 1 minute
Insulation Resistance		(1) Primary to Secondary: 10 MOhm for 500 V DC (2) Primary to Frame Ground: 10 MOhm for 500 V DC
EMI Requirement		CE, FCC Class B, Conduction and Radiation meet
Leakage Current		Less than 3.5 mA
Grounding Test		Resistance 0.1 Ohm max @ 32 A
Environmental	Operating Storage	0 °C to +40 °C -20 °C to +80 °C
Relative humidity	Operating Storage	20% to 80% non-condensing 10% to 90% non-condensing
Regulatory		DoE VI, ErP (Lot 7), GEMS, NRCan, CEC, RoHS
Cable Length		
Supplied AC power input cable (IEC)		1.8 m (6')
Power supply output (+12 V)		1.75 m (5') ± 15 cm (6"), connector HIROSE #HR10A-10P-12S
Strobe		12.5 cm (5") ± 1 cm (0.4") connector BNC male
Trigger		10 cm (4") ± 1 cm (0.4") connector BNC male

Active Canon EF mount

The Canon EF lens mount provides active lens control for C4440, C5440, and C6440 cameras.

The cameras provide communication and power to the mount through an internal connector on the front of the camera. The connector eliminates the need for a special power supply and external cable between the camera and the Canon EF mount.

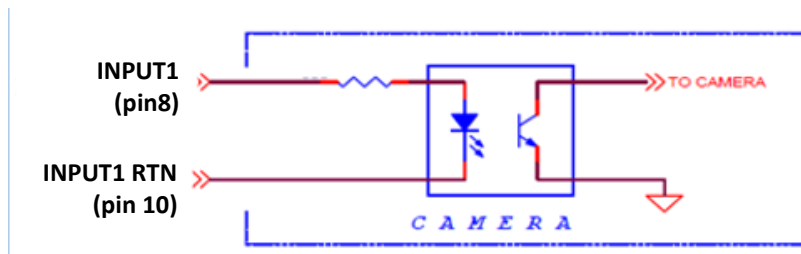


Electrical Connectivity

The Cheetah camera has two external inputs, INPUT1 and INPUT2. INPUT1 is optically isolated while INPUT2 accepts low voltage TTL (LVTTL). The camera provides two general-purpose outputs. Output OUT1 is a 5 V TTL compatible signal and output OUT2 is opto-isolated. The following figures show the external input and output electrical connections.

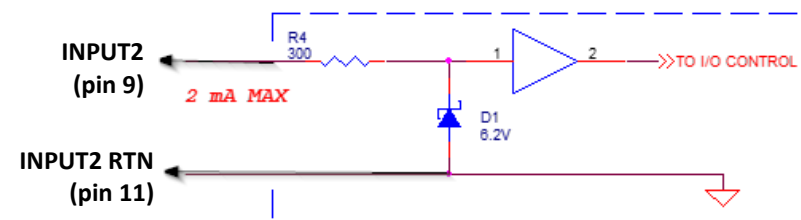
Opto-Isolated Input

Input signals INPUT1 and INPUT1 RTN are optically isolated. The voltage difference between the two must be positive between 3.3 V and 24 V. The minimum input current is 3.3 mA.



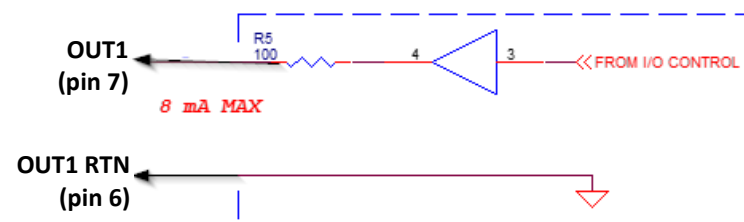
TTL/LVTTL Input

Input signals INPUT2 and INPUT2 RTN provide interfaces to a TTL or LVTTL input signal. The signal level (voltage difference between the inputs INPUT2 and INPUT2 RTN) **must be** LVTTL (3.3 V) or TTL (5.0 V). The total maximum input current **must not** exceed 2.0 mA.



TTL Output

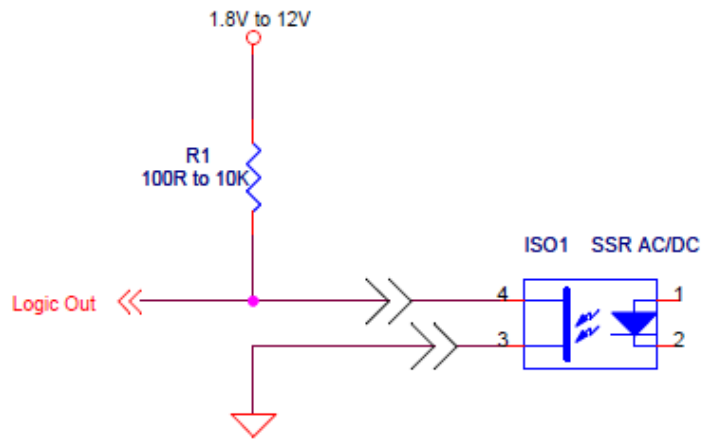
TTL output provides interface to a TTL compatible output signal. The signal level (voltage difference between the outputs OUT1 and OUT1 RTN) is TTL (5.0 V). The maximum output current **must not** exceed 8.0 mA.



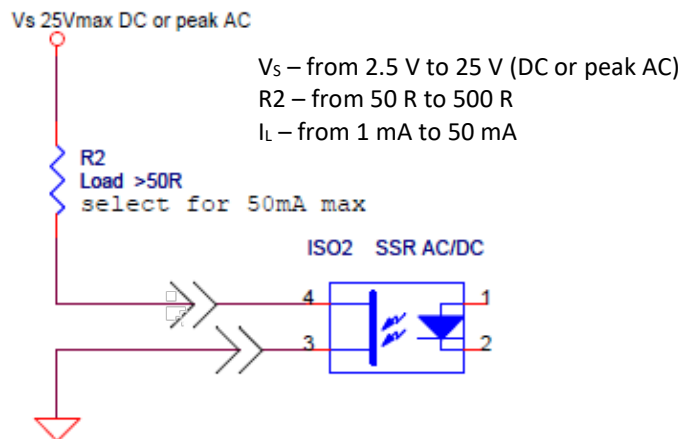
Opto-Isolated Output

Opto-isolated output is an optically isolated switch. There is no pull-up voltage on either contact. An external pull-up voltage of up to 25 V is required for operation. Output is not polarity sensitive. AC or DC loads are possible. The voltage across Contact 1 and Contact 2 **must not** exceed 25 V and the current through the switch **must not** exceed 50 mA. 'On' resistance is less than 5 Ohms.

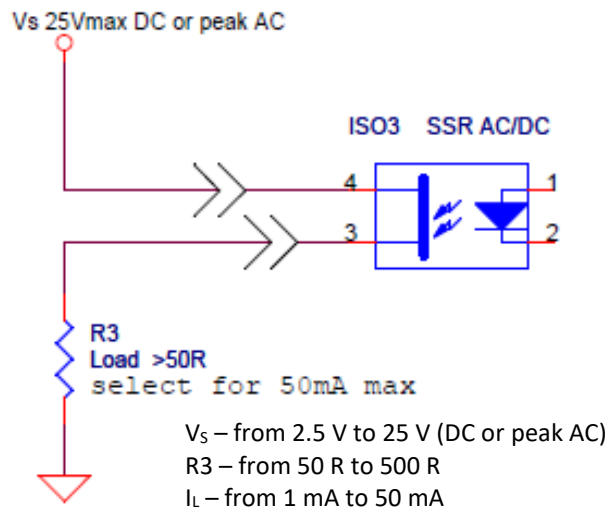
OUT2 Open drain logic driver circuit:



OUT2 Low side load driver circuit:

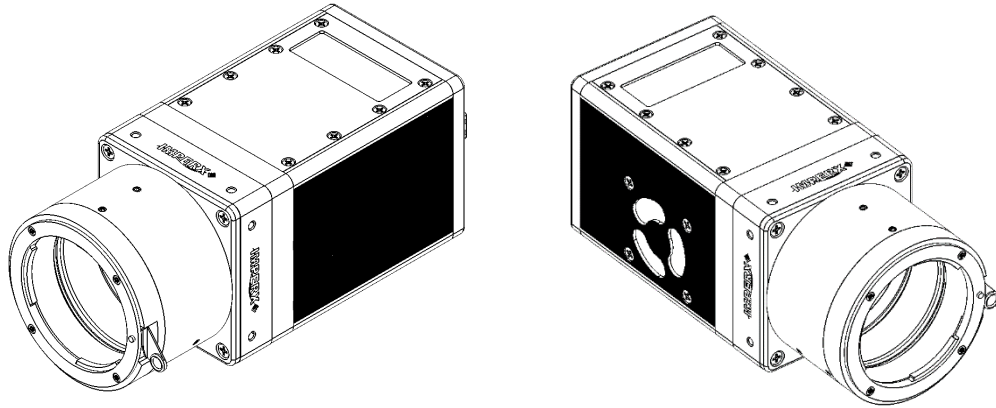


OUT2 High side load driver circuit:



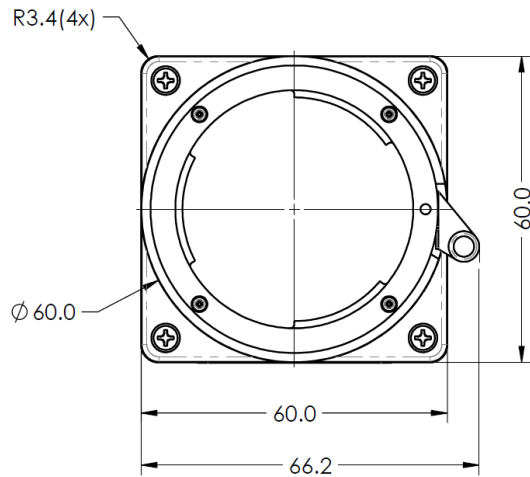
Mechanical Drawings

The camera housing is made of precision-machined aluminum. For maximum flexibility, the camera has eight M3X0.5mm mounting holes located towards the front of the camera on all four sides. An additional plate with ¼-20 UNC (tripod mount) and hardware ship with each camera.

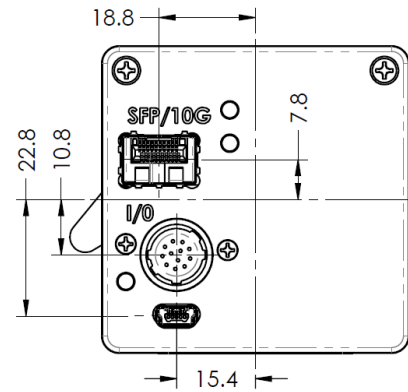


SFP-C4440, SFP-C5440, and SFP-C6440 Cameras

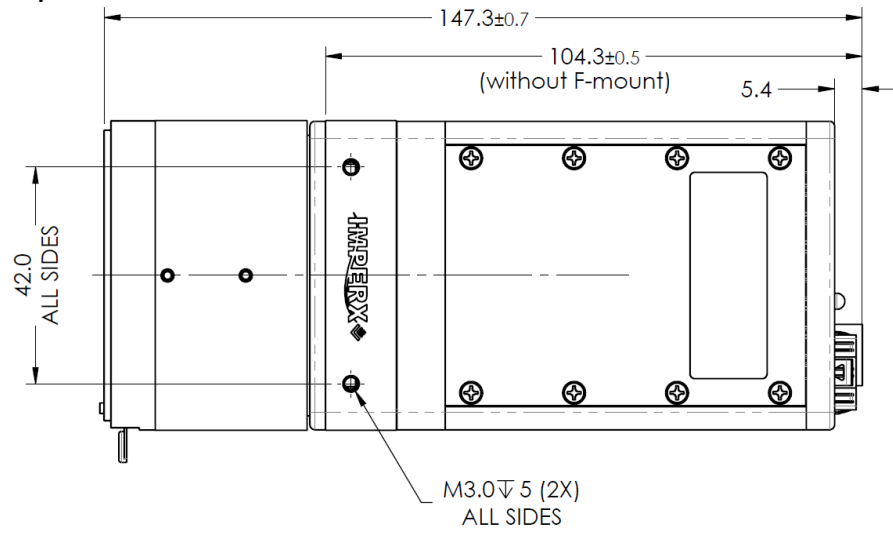
Front View:



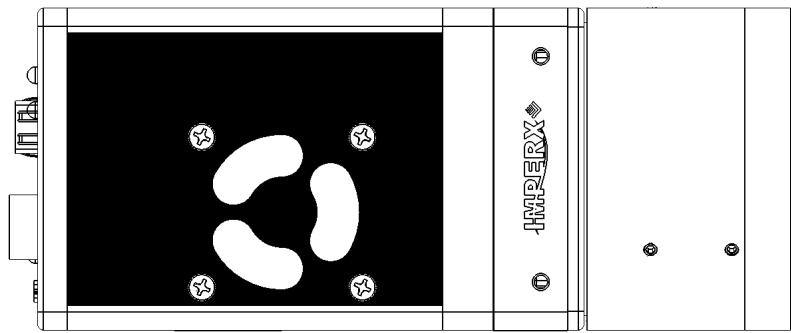
Back View:



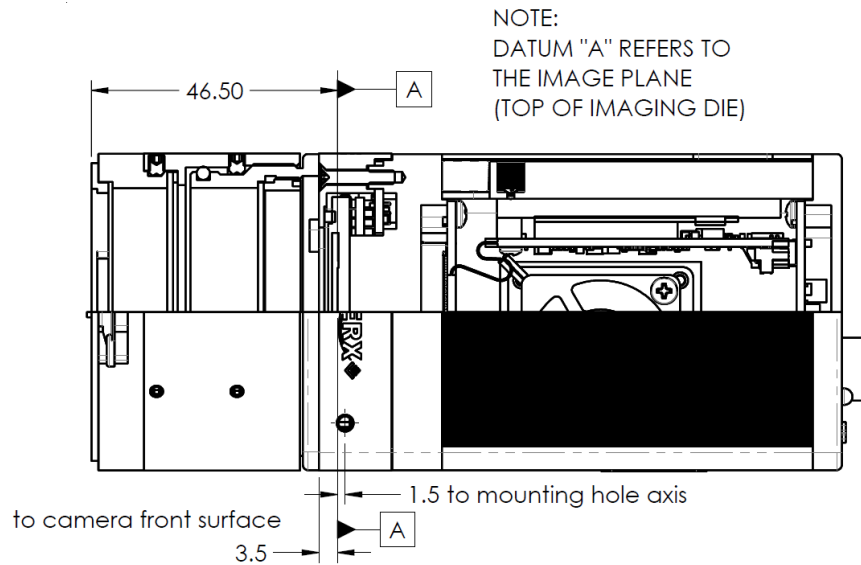
Top View:



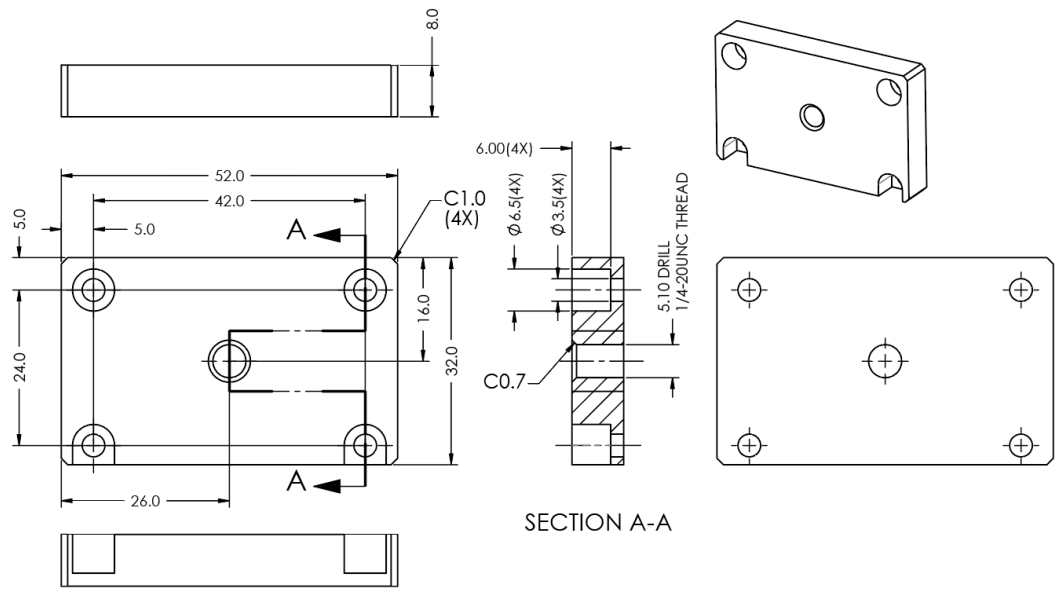
Left Side View:



Right Side View with Image Plane:



Mounting Plate



Optical

The Cheetah 10GigE SFP cameras come with an adapter for F-mount lenses that have a 46.50 mm back focal distance.

The camera can also be equipped with M42, Canon EF EOS Active or Passive mounts (refer to the section [Ordering Information](#)).

The camera is highly sensitive in the infrared (IR) spectral region. All color cameras have an IR cut-off filter installed. Monochrome cameras do not have any optical filter. If necessary, the monochrome camera can accommodate an IR filter (1 mm thickness or less) inserted under the front lens bezel.

CAUTION

Avoid direct exposure to a high intensity light source (such as a laser beam). This may damage the image sensor!

Avoid foreign particles on the surface of the image sensor.

Do not use methylated alcohol for cleaning the image sensor!

Please refer to the Sensor Cleaning Procedure document found in the camera's information ZIP file or contact Imperx support for cleaning procedures.

Avoid touching or cleaning the front surface of the image sensor. If the sensor needs cleaning, use soft lint free cloth and an optical cleaning fluid.

TIP

Camera performance and signal to noise ratio (SNR) depend on the illumination (amount of light) reaching the sensor and the exposure time. Always try to balance these two factors. Unnecessarily long exposures increase the amount of dark noise and thus decrease the signal to noise ratio.

Environmental

Always operate the camera within temperature and humidity specifications listed below:

Specification	Definition
Operating temperature	-30 °C to +70 °C (with a fiber 10GBase-R transceiver module); (may vary depending on the transceiver module used) -30 °C to +45 °C (with a copper 10GBase-T transceiver module)
Storage temperature	-40 °C to + 85 °C
Relative humidity	10% to 90%



Avoid direct exposure to moisture and liquids. The camera housing is not hermetically sealed and any exposure to liquids may damage the camera electronics!

Avoid operating the camera in the environment without any air circulation, near an intensive heat source, strong magnetic or electric fields.

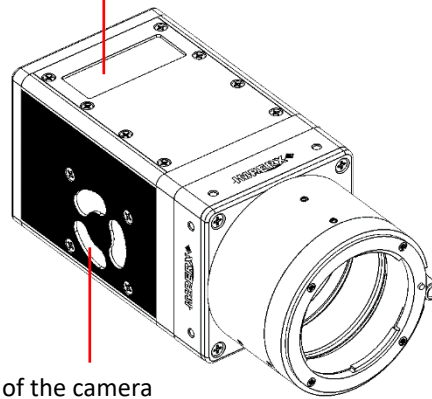
Handling the Camera

CAUTION

When mounting the camera, make sure the inlet and outlet openings are not blocked by surrounding objects. The fan automatically turns on if the internal camera temperature exceeds 65 °C. Keep the fan inlet and outlet clear of obstructions.

Do not touch the camera for at least 20 minutes after shutting it down. Allow the camera to cool down. Hot surface may cause burns.

inlet opening on top of the camera



outlet opening on the left side of the camera

GenICam™ API Module – Configuring the Camera

Overview

Imperx Cheetah cameras are highly programmable and flexible. They allow control of all the camera's resources, camera settings, internal registers, video amplifiers, parameter flash, and so on. You communicate with the camera from a simple GenICam compliant graphical user interface (GUI). The GUI is bi-directional allowing you to issue commands to the camera and allowing the camera to issues responses (either status or information).

The Cheetah camera ships with the Imperx Camera SDK software which includes the SDK and lpxPlayer application to control the camera and view/save images.

Camera Startup

Upon powering up or receiving a DeviceReset command, the camera performs the following steps:

1. Boot loader checks program flash memory for a valid firmware image and loads it into the field-programmable gate array (FPGA).
2. The camera reads the Boot From register from the parameter Flash and loads a workspace from one of the configuration spaces determined by the User Set Default selector. The configuration spaces are: Factory Space (Default), User Space (User set 0–User Set 3).
3. The camera runs the IP configuration according the GigE Vision standard, obtains the IP address, and is ready for device enumeration by host application.

GenApi Camera Configuration

The camera XML nodes are listed below with a description of the camera configuration parameters, the interface type, the range of control values, and the access mode for the parameter (RW: Read/Write, RO: Read Only, WO: Write Only).

NOTE (★) In the following tables, parameter names highlighted in *red italic* letters are changeable only if image acquisition is turned **off**. You cannot change these parameters if image acquisition is on. After making changes, you can turn the camera image acquisition back **on**.

Device Control

Device Control provides read-only information about the camera's XML file and enables camera reset functionality.

Parameter Name	Type	Value	Access	Description	
DeviceVendorName	String		RO	Provides the name of the manufacturer of the camera	
DeviceModelName	String		RO	Provides the model of the device	
DeviceVersion	String		RO	Provides the version of the camera	
DeviceFirmwareVersion	String		RO	Provides firmware version of the camera	
DeviceManufacturerInfo	String		RO	Provides extended manufacturer information about the camera	
DeviceSerialNumber	String		RO	Provides serial number of the camera	
DeviceUserID	String		RW	Provides user defined name of the device	
DeviceSFNCVersionMajor	Integer		RO	Major version of SFNC used for XML.	
DeviceSFNCVersionMinor	Integer		RO	Minor version of SFNC used for XML	
DeviceSFNCVersionSubMinor	Integer		RO	Sub-minor version of SFNC used for XML	
DeviceScanType	Enumeration	String Areascan	Num. 0	RO	Specifies the scan type of the sensor
DeviceReset	Command		WO	Resets camera to power-up state (resets both the 10G Engine and the camera head)	
CameraHeadReset	Command		WO	Resets the camera circuitry. The 10G Engine does not reset. NOTE: After a camera reset, issue a UserSetLoad command	
SensorTemperature	Float		RO	Returns the current sensor temperature	
SensorBoardTemperature	Float		RO	Returns the current sensor board temperature	
FPGATemperature	Float		RO	Returns the current FPGA temperature	
FPGABoardTemperature	Float		RO	Returns the current FPGA board temperature.	

Temperature Control

Temperature Control allows you to set the fan's operation mode and the temperature at which the fan turns on in Auto mode.

NOTE (*) The fan automatically turns on—even if the fan operation mode is Off—when the internal camera temperature exceeds 65 °C.

Parameter Name	Type	Value	Access	Description	
FanMode	Enumeration	String	Num.	RW	Sets the operation mode of the camera fan.
		Off	0		
		On	1		
		Auto	2		
FanOnTemperature	Float		RW	Sets the temperature, in Celsius degrees, when the camera fan turns on to cool the camera (in Auto mode). Fan turns off when the internal camera temperature is 4 °C below the set temperature.	

Version Information

Version Information provides read-only information identifying the camera's firmware, hardware, software, image sensor, camera version, and so on. This information is programmed during the manufacturing process and stored in non-volatile memory.

Parameter Name	Type	Value	Access	Description
SensorType	Enumeration	String Monochrome Bayer	Num. 0 1	RO Returns the CMOS sensor type.
SensorModel	Enumeration	String Unknown IMX342LQ IMX342LL IMX367LQ IMX367LL IMX387LQ IMX387LL	Num. 0 0x00000156 0x00000556 0x0000016F 0x0000056F 0x00000183 0x00000583	RO Returns the CMOS model name.
RgsID	Integer			RO Returns RGS ID.
FirmwareImage	Integer			RO Returns the firmware image ID (F=Factory or A= Application).
CameraHeadFirmwareVersion	Integer			RO Returns the camera head firmware version number.
CameraHeadFirmwareBuild	Integer			RO Returns the camera head firmware build number.
FirmwareVersion	Integer			RO Returns the firmware version number.
FirmwareBuild	Integer			RO Returns firmware build number.
CustomerID	Integer			RO Returns Customer ID for custom cameras (0 = Imperx Standard camera).
FamilyID	Integer			RO Returns the camera family ID.
XMLVersion	Integer			RO Returns XML version.

Image Format Control

Image Format Control lets you change screen resolution, select pixel format, and more.

Parameter Name	Type	Value	Access	Description	
SensorWidth	Integer		RO	Returns effective width of sensor in pixels.	
SensorHeight	Integer		RO	Returns effective height of sensor in pixels.	
WidthMax	Integer		RO	Returns max. width of image in pixels for <i>OffsetX=0</i> calculated after horizontal binning, decimation, or other functions are applied.	
HeightMax	Integer		RO	Returns max. height of image in pixels <i>OffsetY=0</i> calculated after horizontal binning, decimation, or other functions are applied.	
<i>Width</i>	Integer	Min: Depends on <i>PixelFormat</i> Max: Depends on camera model	RW	Represents actual image output width of master AOI (in pixels).	
<i>Height</i>	Integer	Min: Depends on <i>PixelFormat</i> Max: Depends on camera model	RW	Represents actual image output height of master AOI (in pixels).	
OffsetX	Integer	Min: 0 Max: Depends on <i>Width</i>	RW	Horizontal offset from origin to area of interest (in pixels).	
OffsetY	Integer	Min: 0 Max: Depends on <i>Height</i>	RW	Vertical offset from origin to area of interest (in pixels).	
PixelFormat	Enumeration	String Bpp8 Bpp10 Bpp12	Num. 0 1 2	RO	Number of bits per pixel.
PixelFormatFilter	Enumeration	String None BayerRG BayerGB BayerGR BayerBG	Num. 0 1 2 3 4	RO	Returns type of color filter that is applied to the image.

Parameter Name	Type	Value	Access	Description	
<i>PixelFormat</i>	Enumeration	String	Num.	RW	Sets output data pixel format. Color cameras, without image flipping or reversal, use BayerRG8, BayerRG10 or BayerRG12, BayerRG10Packed or BayerRG12Packed format.
		Mono8	0x01080001		
		Mono10	0x01100003		
		Mono10Packed	0x010C0004		
		Mono12	0x01100005		
		Mono12Packed	0x01100005		
		BayerGR8	0x01080008		
		BayerRG8	0x01080009		
		BayerGB8	0x0108000A		
		BayerBG8	0x0108000B		
		BayerGR10	0x0110000C		
		BayerRG10	0x0110000D		
		BayerGB10	0x0110000E		
		BayerBG10	0x0110000F		
		BayerGR12	0x01100010		
		BayerRG12	0x01100011		
		BayerGB12	0x01100012		
		BayerBG12	0x01100013		
		BayerGR10Packed	0x010C0026		
		BayerRG10Packed	0x010C0027		
BayerGB10Packed	0x010C0028				
BayerBG10Packed	0x010C0029				
BayerGR12Packed	0x010C002A				
BayerRG12Packed	0x010C002B				
BayerGB12Packed	0x010C002C				
BayerBG12Packed	0x010C002D				
BinningVerticalMode ¹	Enumeration	String Sum	Num. 0	RO	Returns the mode used to combine horizontal photo-sensitive cells together when <i>BinningVertical</i> is used.
<i>BinningVertical</i>	Integer	Min: 1 Max: 2		RW	Number of vertical photo-sensitive cells to combine. This reduces the vertical resolution (height) of the image
BinningHorizontalMode ¹	Enumeration	String Sum	Num. 0	RO	Returns the mode used to combine horizontal photo-sensitive cells together when <i>BinningHorizontal</i> is used.
<i>BinningHorizontal</i>	Integer	Min: 1 Max: 2		RW	Number of horizontal photo-sensitive cells to combine. This reduces the horizontal resolution (width) of the image.

Parameter Name	Type	Value	Access	Description
<i>DecimationVertical</i>	Integer	Min: 1 Max: 2	RW	Vertical sub-sampling of the image. This reduces the vertical resolution (height) of the image by the specified vertical decimation factor.
<i>DecimationHorizontal</i>	Integer	Min: 1 Max: 2	RW	Horizontal sub-sampling of the image. This reduces the horizontal resolution (width) of the image by the specified horizontal decimation factor.
<i>ReverseX</i> ²	Boolean		RW	Horizontally flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
<i>ReverseY</i> ²	Boolean		RW	Vertically flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
TestPattern ³	Enumeration	String Off GreyHorizontalRamp GreyVerticalRamp GreyHorizontalRampMoving GreyVerticalRampMoving FlatField IpxGevPattern	Num 0 1 2 3 4 5 16	RW Selects type of test pattern generated by the camera replacing the image sensor as the source (refer to section Test Image Pattern for more information).
<i>SensorTestPattern</i> ⁴	Enumeration	String Off Mode0 Mode1	Num 0 1 2	RW Selects the type of test pattern that is generated by the camera image sensor. Mode0 and Mode1 are used to verify the sensor's connectivity to an FPGA
AdcBitDepth	Enumeration	String Bit10 Bit12	Num 10 12	RO Returns which ADC bit depth is used. A higher ADC bit depth results in better image quality but slower maximum frame rate.

Parameter Name	Type	Value	Access	Description
SensorShutterMode	Enumeration	String Global	Num 1	RO Returns the shutter mode of the device.

¹**BinningHorizontal/Vertical Mode** value:

Sum: The response from the combined cells is added, resulting in increased sensitivity.

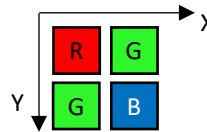
NOTE (*) Currently, the camera performs **Summation** mode only.

To enable binning feature, set *BinningHorizontal* or *BinningVertical* to 2.

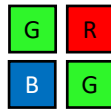
The binning is disabled when *DecimationVertical* or *DecimationHorizontal* is enabled, and vice versa.

²When *ReverseX* and/or *ReverseY* are enabled for a color camera, the *PixelFormat* changes automatically according to the current Bayer pattern start pixel:

Original *PixelFormat*: BayerRG8



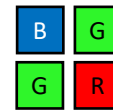
ReverseX is enabled
New *PixelFormat*: BayerGR8



ReverseY is enabled
New *PixelFormat*: BayerGB8



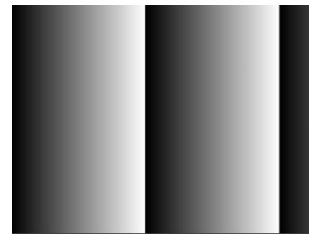
ReverseX and *ReverseY* are enabled together
New *PixelFormat*: BayerBG8



³**Test Pattern** values:

Off: Image is coming from the sensor

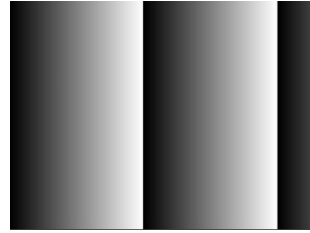
GreyHorizontalRamp: Image is filled horizontally with a digital pattern that goes from the darkest possible value to the brightest.



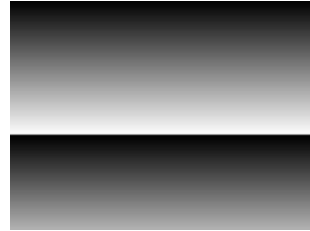
GreyVerticalRamp: Image is filled vertically with a digital pattern that goes from the darkest possible value to the brightest.



GreyHorizontalRampMoving: Image is filled horizontally with digital pattern that goes from the darkest possible value to the brightest and that moves horizontally from left to right at each frame.



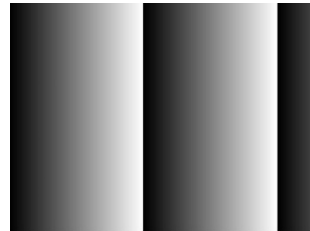
GreyVerticalRampMoving: Image is filled vertically with digital pattern that goes from the darkest possible value to the brightest and that moves vertically from top to bottom at each frame.



FlatField: Displays a constant grey level for all display pixels.

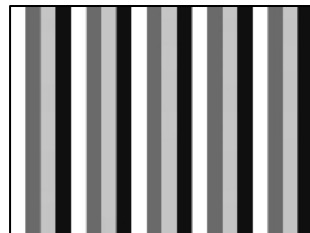


IpxGevPattern: GEV engine firmware generate an image.



⁴Sensor Test Pattern values:

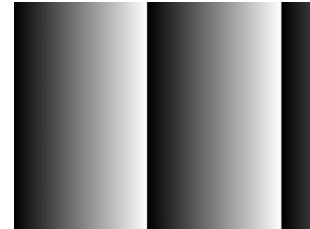
Mode0: The sensor test image is filled with a vertical stripe pattern of one pixel width. Values are:
 12-bit: FFFh/555h/AAAh/000h
 10-bit: 3FFh/155h/2AAh/000h
 8-bit: FFh/55h/Aah/00h



This ensures that the connection between the sensor and FPGA is synchronized.

*For color cameras, make sure that *BalanceRatio* is set to 1.0 and *BalanceWhiteAuto* is Off.

Mode1: The sensor test image is filled horizontally with digital pattern that goes from the darkest possible value to the brightest.
 This ensures that the connection between the sensor and FPGA is synchronized.



Acquisition Control

Acquisition Control lets you configure settings for image capture, exposure, frame rates, triggers, and so on. It also provides read-only information on frame and exposure time.

Parameter Name	Type	Value	Access	Description
AcquisitionMode	Enumeration	String SingleFrame MultiFrame Continuous	Num. RW 0 1 2	Defines the number of frames to capture during acquisition and the way the acquisition stops
AcquisitionStart	Command		WO	Starts device acquisition.
AcquisitionStop	Command		WO	Stops acquisition after current frame completes readout.
AcquisitionAbort	Command		WO	Stops acquisition immediately; a partially transferred image will be completed.
<i>AcquisitionFrameCount</i>	Integer	Min: 1 Max: 65535	RW	Sets the number of frames to be acquired in MultiFrame AcquisitionMode.
<i>ExposureMode</i> ¹	Enumeration	String Off Timed TriggerWidth	Num. RW 0 1 2	Sets exposure mode (refer to Exposure Control for more information).
ExposureTime ²	Float		RW	Sets the exposure time in microseconds when ExposureMode is Timed and ExposureAuto is Off.
ExposureAuto	Enumeration	String Off Once Continuous	Num. RW 0 1 2	Sets the automatic exposure mode when ExposureMode is Timed.
<i>AcquisitionFrameRateEnable</i>	Boolean		RW	Controls if the AcquisitionFrameRate and AcquisitionFrameTime features are writable and used to control the acquisition rate. If On, you can extend the actual frame time beyond the free-running frame time. Trigger is disabled and cannot be used in combination with this feature.
AcquisitionFrameTime	Integer		RW	Sets Frame Time in microseconds.

Parameter Name	Type	Value	Access	Description	
AcquisitionFrameRate	Float		RW	Controls the acquisition rate (in Hz) of frames captured.	
<i>AcquisitionLineTimeEnable</i>	Boolean		RW	Controls if the <i>AcquisitionLineTime</i> feature are writable and used to control the acquisition line time.	
AcquisitionLineTime	Integer		RW	This feature sets the actual line time in pixel clocks (74.25MHz).	
<i>AcquisitionBurstFrameCount</i>	Integer	Min: 1 Max: 65535	RW	Number of frames to acquire for each trigger.	
CurrentExposureTime	Integer		RO	Returns current exposure time in microseconds.	
CurrentFrameTime	Integer		RO	Returns current frame time in microseconds.	
<i>TriggerMode</i>	Enumeration	String Off On	Num. 0 1	RW	Enables Trigger mode of operation. Not available if <i>AcquisitionFrameRateEnable</i> parameter is On.
TriggerSoftware	Command		WO	Generates internal trigger. <i>TriggerSource</i> must be set to Software.	
<i>TriggerSource</i> ³	Enumeration	String Line1 Line2 PulseGenerator Software	Num. 0 1 4 5	RW	Specifies internal signal or external Line as trigger source. <i>TriggerMode</i> must be set to On (refer to Trigger Sources for more information).
<i>TriggerActivation</i>	Enumeration	String RisingEdge FallingEdge	Num. 0 1	RW	Specifies activation edge of trigger.
<i>TriggerOverlap</i>	Enumeration	String Off ReadOut	Num. 0 1	RW	Specifies the trigger overlap mode, if the camera receives a trigger pulse while processing the previous trigger. Off – Standard Trigger mode; ReadOut – Fast Trigger mode.
<i>TriggerDebounceTime</i>	Integer	Min: 0 Max: 65535	RW	Specifies time period (in microseconds) when a second trigger is not accepted.	

Parameter Name	Type	Value	Access	Description
<i>TriggerFilterTime</i>	Integer	Min: 0 Max: 65535	RW	Specifies the minimum Trigger signal pulse width. Any pulse shorter than the selected time is ignored.
<i>TriggerDelay</i>	Integer	Min: 0 Max: 16000000	RW	Specifies delay between trigger and start of exposure (in microseconds).

¹**Exposure Mode** values:

Off	Disables the Exposure. The exposure time is equal to frame time.
Timed	The exposure duration is set by the <i>ExposureTime</i> or <i>ExposureAuto</i> features.
TriggerWidth	The exposure duration is set by the width of the current trigger signal pulse. Note that if <i>TriggerActivation</i> is set to <i>RisingEdge</i> , the exposure duration will be the time the trigger stays high. If <i>TriggerActivation</i> is set to <i>FallingEdge</i> , the exposure time lasts as long as the trigger stays low.

²**ExposureTime:** The maximum exposure time is equal to the frame time. For longer exposure times, increase the frame period using the *AcquisitionFrameTime* or *AcquisitionFrameRate* features.

³**TriggerSource** values:

Line1	Hardware Input Line GP Input 1 (Trigger 1) is used as external source for the trigger signal.
Line2	Hardware Input Line GP Input 2 (Trigger 2) is be used as external source for the trigger signal.
PulseGenerator	Specifies that the trigger source will be generated by camera's internal Pulse Generator.
Software	Specifies that the trigger source will be generated by software using the <i>TriggerSoftware</i> command.

Analog Control

Analog Control provides parameters for configuring gain, black level, gamma correction, and auto white balance.

Parameter Name	Type	Value	Access	Description
Gain	Float	Min: 0.0 Max: 48.0	RW	Controls the selected gain as an absolute physical value. This is an amplification factor applied to the video signal.
GainAuto	Enumeration	String Off Once Continuous	Num. 0 1 2 RW	Sets the automatic gain control (AGC) mode. <i>ExposureMode</i> can be set to Timed, PulseWidth, or Off.
BlackLevel	Float	Min: 0.0 Max: 4095.0	RW	Controls the on-sensor analog black level as an absolute physical value. This represents a DC offset applied to the video signal.
SensorBlackLevelRecommended	Boolean		RW	Uses recommended value of <i>BlackLevel</i> from the sensor.
BlackLevelAuto	Enumeration	String Off Continuous	Num. 0 1 RW	Sets the on-sensor mode for automatic black level adjustment.
DigitalGain	Float	Min: 0.0 Max: 4.0	RW	Controls the Digital Gain.
DigitalBlackLevel	Float	Min: -4096.0 Max: 4095.0	RW	Controls the Digital Black Level.
BalanceRatioSelector	Enumeration	String Red Blue	Num. 0 1 RW	White Balance Control: Selects which color will be impacted by the <i>BalanceRatio</i> control.
BalanceRatio	Float	Min: 0.25 Max: 4.00	RW	White balance color ratio. Controls ratio of the selected color component to green, which is the reference color. If the Red and Blue Balance ratios are manually set to 1.0, no white balance correction is applied to the pixels.
BalanceWhiteAuto	Enumeration	String Off Once Continuous	Num. 0 1 2 RW	Controls the mode for automatic white balancing between the color channels. The white balancing color ratios are automatically adjusted by selecting either Once or Continuous. If Off, the White Balance color ratios are set manually using <i>BalanceRatioSelector</i> and <i>BalanceRatio</i> controls.

Auto White Balance, Exposure and Gain Algorithm Control

Auto Algorithm Control lets you configure settings for AWB (Automatic White Balance), AEC (Automatic Exposure Control), and AGC (Automatic Gain Control) algorithms.

You can set the camera to AEC/AGC to keep the same image brightness during changing lighting conditions. On the Auto Algorithm Control panel, you can configure the range of exposure times and gain values for AEC/AGC by placing minimum and maximum limits on these parameters.

Parameter Name	Type	Value	Access	Description
BalanceWhiteAutoLowerLimit	Float	Min: 0.25 Max: BalanceWhiteAutoLowerLimitMax	RW	Controls the minimum value AWB can set for the Red/Blue <i>BalanceRatio</i> .
BalanceWhiteAutoUpperLimit	Float	Min: 0.25 Max: BalanceWhiteAutoUpperLimitMax	RW	Controls the maximum value AWB can set for the Red/Blue <i>BalanceRatio</i> .
BalanceWhiteAutoSpeed	Integer	Min: 1 Max: 64	RW	Speed of AWB algorithm. 1 is slowest, 64 is fastest.
ExposureAutoLowerLimit	Float	Min: ExposureTimeMin Max: ExposureAutoUpperLimit	RW	The shortest exposure time that Auto Exposure can set
ExposureAutoUpperLimit	Float	Min: ExposureAutoLowerLimit Max: ExposureTimeMax	RW	The longest exposure time that Auto Exposure can set.
GainAutoLowerLimit	Float	Min: 0.0 Max: GainAutoUpperLimit	RW	The lowest gain that Auto Gain can set.
GainAutoUpperLimit	Float	Min: GainAutoLowerLimit Max: 48.0	RW	The highest gain that Auto Gain can set.
ExposureGainAutoPriority	Enumeration	String Gain ExposureTime	Num. 0 1 RW	Selects whether to adjust gain or exposure first.
ExposureGainAutoMode	Enumeration	String Average	Num. 0 RO	Shows what luminance mode is used during AGC or AEC.
ExposureGainAutoTarget	Integer	Min: 1 Max: 4095	RW	Sets the desired luminance level to be maintained during AGC or AEC with 12-bits per pixel.

Parameter Name	Type	Value	Access	Description
ExposureGainAutoTargetThres hold	Integer	Min: 0 Max: 4095	RW	Sets the acceptable steady-state error of the luminance level to be maintained during AGC or AEC. Normal initial setting for stability is 16.
AverageLuminosity	Integer		RO	Shows average luminosity of the image.
CurrentFrameCounterLow	Integer		RO	Shows number of frames captured since the camera power up (lower 32 bits).
CurrentFrameCounterHigh	Integer		RO	Shows number of frames captured since the camera power up (upper 32-bits).

Exposure Auto PID Coefficients



Imperx do not recommend changing min and max limits of the P coefficient. Doing so may cause oscillations and destabilize a PID controller. Imperx sets up optimal values to balance the speed and stability of the AEC algorithm.

If you need to change the P coefficient, please contact Imperx support.

Parameter Name	Type	Value	Access	Description
ExposureAutoPMin	Float	Min: 0.0 Max: 256.0	RW	Controls the minimum of the P coefficient for Exposure Auto control loop.
ExposureAutoPMax	Float	Min: 0.0 Max: 256.0	RW	Controls the maximum of the P coefficient for Exposure Auto control loop.
ExposureAutoExposureForPMax	Float	Min: ExposureTimeMin Max:	RW	Maps the maximum of the P coefficient to the value of exposure in the Exposure Auto control loop.

Please refer to the section [P, I, and D Coefficients](#) for more information.

Gain Auto PID Coefficients

**CAUTION**

Imperx does not recommend changing the P, I, and D coefficients. Doing so may cause oscillations and destabilize a PID controller. Imperx sets up optimal values to balance the speed and stability of the AGC algorithm.

If you need to change the P, I, and D coefficients, please contact Imperx support.

Parameter Name	Type	Value	Access	Description
GainAutoPcoef	Float	Min: 0.0 Max: 256.0	RW	Controls the P coefficient for Gain Auto control loop.
GainAutoIcoef	Float	Min: 0.0 Max: 256.0	RW	Controls the I coefficient for Gain Auto control loop.
GainAutoDcoef	Float	Min: 0.0 Max: 256.0	RW	Controls the D coefficient for Gain Auto control loop.

Please refer to the section [P, I, and D Coefficients](#) for more information.

Data Correction

Data Correction parameters enable you to implement look-up tables and other techniques to improve image sensor performance.

Parameter Name	Type	Value	Access	Description
LUTEnable	Enumeration	String	Num. RW	Selects and enables LUT to be used in processing image. (LUT1 and LUT3 are preprogrammed with Gamma 0.45, LUT 2 and LUT 4 – with negative function)
		Off	0	
		LUT1	1	
		LUT2	2	
		LUT3	3	
FFCEnable	Enumeration	String	Num. RW	Selects FFC to be used in processing image.
		Off	0	
		FactoryFFC	1	
		FFC1	2	
		FFC2	3	
		FFC3	4	
		FFC4	5	
		FFC5	6	
DefectPixelCorrection	Enumeration	String	Num. RW	Enables defect pixel correction. You can upload your own defect pixel map.
		Off	0	
		Factory	1	
DefectPixelCorrectionMode ¹	Enumeration	String	Num. RW	Controls the method used for replacing defective pixels (Highlight and Zero are for testing purposes only)
		Average	0	
		Highlight	1	
		Zero	2	
BadPixelCorrection	Enumeration	String	Num. RW	Enables Hot Pixel Correction. You can upload your own hot pixel map.
		Off	0	
		Factory	1	
BadPixelCorrectionMode ¹	Enumeration	String	Num. RW	Controls the method used for replacing hot pixels (Highlight and Zero are for testing purposes only).
		Average	0	
		Highlight	1	
		Zero	2	
DefectPixelCountMax	Integer		RO	Maximum number of pixels in the Defect Pixel Correction Table.
BadPixelCountMax	Integer		RO	Maximum number of pixels in the Hot Pixel Correction Table.

¹**DefectPixelCorrectionMode** and **BadPixelCorrectionMode** values:

Average	Defective or Hot Pixels are replaced with the average of their neighbors.
Highlight	Defective or Hot Pixels are replaced with the maximum pixel value.
Zero	Defective or Hot Pixels are replaced by the value zero.

Digital Input / Output Control

Digital Input / Output Control allows you to map camera's inputs and outputs and configure strobes.

Parameter Name	Type	Value	Num.	Access	Description
LineSelector	Enumeration	String		RW	Selects the physical line (or pin) of the external camera connector or the virtual line of the Transport Layer to configure.
		Input1	0		
		Input2	1		
		Output1	2		
		Output2	3		
LineMode	Enumeration	String		RO	Returns the status of the physical line used to input or output a signal.
		Input	0		
		Output	1		
LineInverter	Boolean			RW	Controls the inversion of the signal of the selected input or output line.
LineStatus	Boolean	logic 1 – true logic 0 – false		RO	Returns the current signal level on the selected input or output line.
LineSource ¹	Enumeration	String		RW	Selects which internal signal to output on the selected line. <i>LineSelector</i> must be set to Output.
		Off	0		
		ExposureStart	1		
		ExposureEnd	2		
		MidExposure	3		
		ExposureActive	4		
		TriggerActual	5		
		TriggerDelayed	6		
		PulseGenerator	7		
		Strobe1	8		
Strobe2	9				
LineFormat ²	Enumeration	String		RO	Returns the current electrical format of the selected physical input or output line.
		NoConnect	0		
		TriState	1		
		TTL	2		
		OptoCoupled	3		
Strobe1Reference	Enumeration	String		RW	Sets the reference event for Strobe #1 signal.
		Exposure	0		
		Readout	1		
		Trigger	2		
Strobe1Enable	Enumeration	String		RW	Enables or disables the Strobe #1.
		Off	0		
		On	1		
Strobe1Width	Integer	Min: 10 Max: 16000000		RW	Sets Strobe #1 pulse duration in microseconds.
Strobe1Delay	Integer	Min: 0 Max: 16000000		RW	Sets Strobe #1 delay from the reference, in microseconds.

Parameter Name	Type	Value	Access	Description
Strobe2Reference	Enumeration	String Exposure Readout Trigger	Num. 0 1 2	RW Sets the reference event for Strobe #2 signal.
Strobe2Enable	Enumeration	String Off On	Num. 0 1	RW Enables or disables the Strobe #2.
Strobe2Width	Integer	Min: 10 Max: 16000000	RW	Sets Strobe #2 pulse duration in microseconds.
Strobe2Delay	Integer	Min: 0 Max: 16000000	RW	Sets Strobe #2 delay from the reference, in microseconds.

¹**LineSource** values (for outputs only):

ExposureStart	A short pulse indicating the beginning of the exposure
ExposureEnd	A short pulse indicating the end of the exposure
MidExposure	A short pulse indicating the middle of the exposure
ExposureActive	The output signal is active for the duration of exposure time
TriggerActual	Maps the input trigger pulse to the output with no delay
TriggerDelayed	Maps the input trigger pulse to the output with trigger delay
PulseGenerator	Maps the internal pulse generator waveform to the output
Strobe1	Maps the Strobe 1 signal to the corresponding external output
Strobe2	Maps the Strobe 2 signal to the corresponding external output

²**LineFormat** values:

NoConnect	The line is not connected
TriState	The line is currently in Tri-State mode (Not driven)
TTL	The line is currently accepting or sending TTL level signals
OptoCoupled	The line is opto-coupled

You can monitor the current logic level (1 or 0) of the signal on the selected input or output by using the *LineStatus* parameter.

The *LineMode* parameter shows the status of the selected input or output line.

Depending on line selected under *LineSelector* (Input or Output), you can apply the following controls:

LineSelector	Available controls	Values
Input1 or Input2	<i>LineInverter</i>	True
		False
Output1 or Output2	<i>LineInverter</i>	True
		False
	<i>LineSource</i>	Off
		ExposureStart
		ExposureEnd
		MidExposure
		ExposureActive
		TriggerActual
		TriggerDelayed
		PulseGenerator
		Strobe1
Strobe2		

Pulse Generator

The camera provides an internal pulse generator for generating a trigger signal. You can program it to generate a discrete sequence or a continuous trail of pulse signals.

Parameter Name	Type	Value	Access	Description
PulseGenGranularity	Enumeration	String x1uS x10uS x100uS x1000uS	Num. 0 1 2 3	RW Sets the multiplication factors of the Pulse Generator where x1 = 1 μ S, x10=10 μ S, etc.
PulseGenWidth	Integer		RW	Sets pulse width of Pulse Generator where each unit is equal to <i>PulseGenGranularity</i> .
PulseGenPeriod	Integer		RW	Sets pulse period of Pulse Generator where each unit is equal to <i>PulseGenGranularity</i> .
PulseGenNumPulses	Integer	Min: 1 Max: 65536	RW	Sets number of pulses to be generated by Pulse Generator.
PulseGenMode	Enumeration	String Continuous NumPulses	Num. 0 1	RW Sets the mode of the Pulse Generator.
PulseGenEnable	Boolean		RW	Enables Pulse Generator. The pulse generator output can be mapped to the OUTPUT1 or OUTPUT2 output signals. It also can be used as a trigger source.

Canon Lens Control

Canon EF Lens supports motorized iris and focus (not zoom). Canon Lens Control parameters give you control over iris and focus position. Refer to the [Canon Lens Control](#) section for more information on lens adjusting procedures.

Controller Settings

Parameter Name	Type	Value	Access	Description
InitLens	Command		WO	Initializes the Canon Lens. Always initialize lens after power up.
StopLens	Command		WO	Removes power from the Iris drive. Run the <i>InitLens</i> command to resume the lens control.
LensControllerStatus	Enumeration	String InitLens_Failed InitLens_Done	Num. 0 1	RO Shows status of Canon Lens initialization.
LensAF_MF	Enumeration	String AutoFocus ManualFocus	Num. 0 1	RO Shows status of Auto/Manual focus switch located on the lens.
GetLensID	Command		WO	Requests value of Lens ID register.
LensID	Integer		RO	Returns Lens ID after the <i>GetLensID</i> command is issued.

Focus

Parameter Name	Type	Value	Access	Description
NearFull	Command		WO	Drives the focus to the fully Near position.
FarFull	Command		WO	Drives the focus to the fully Far position.
FocusSetupValue	Integer	Min: 1 Max: 255	RW	Sets the focus step used with NearStep and FarStep commands.
NearStep	Command		WO	Drives the focus to the Near direction by the amount defined in the <i>FocusStepValue</i> feature.
FarStep	Command		WO	Drives the focus in the Far direction by the amount defined in the <i>FocusStepValue</i> feature.
FocusReqPosition	Integer	Min: 0 Max: FocusMaxReg	RW	Sets the desired focus value to use with the <i>SetFocusPosition</i> command.
SetFocusPosition	Command		WO	Drives the focus to the absolute position defined in the <i>FocusReqPosition</i> feature.
FocusMax	Integer		RO	Returns Maximum Focus Limit
FocusSetMax	Command		WO	Sets the Maximum Focus Limit
GetFocusEncoderStatus	Command		WO	Requests the focus encoder position value.
FocusEncoderStatus	Integer		RO	Returns the current focus encoder value after the GetFocusEncoderStatus command issued.
ResetFocusEncoder	Command		WO	Resets the Focus encoder.

Iris

Parameter Name	Type	Value	Access	Description
IrisRequestedPositionRaw	Integer	Min: IrisMin2 Max: IrisMax	RW	Sets raw iris absolute position.
SetIrisPosition	Command		WO	Drives the iris to the absolute position value of <i>IrisRequestedPositionRaw</i> .
CurrentFNumber	Float		RO	Returns the current f-number value of the lens iris. A Value of 0.0 means the iris position is unknown
OpenIrisFull	Command		WO	Opens the iris to the fully opened position.
CloseIrisStep	Command		WO	Closes the iris by the amount defined in the <i>IrisStepValue</i> feature.
OpenIrisStep	Command		WO	Opens the iris by the amount defined in the <i>IrisStepValue</i> feature.
IrisStepValue	Integer	Min: 1 Max: 127	RW	Sets the iris step to be used with <i>OpenStep</i> and <i>CloseStep</i> commands.
GetIrisRange	Command		WO	Sends the <i>Get Iris Range</i> command to the camera.
IrisMin	Integer		RO	Returns the minimum iris limit.
IrisMax	Integer		RO	Returns the maximum iris limit.
IrisRange	Integer		RO	Displays the limit values of the iris, after the <i>GetIrisRange</i> command issued.

Transport Layer Control

The Transport Layer Control provides a variety of configuration settings and read-only information for configuring communications between the cameras and other devices with the 10 GigE Vision interface.

Parameter Name	Type	Value	Access	Description
PayloadSize	Integer		RO	Provides the number of bytes transferred for each image on the stream channel, including any end-of-line, end-of-frame statistics or other stamp data.

GigE Vision

Parameter Name	Type	Value	Access	Description
GevMACAddress	Integer		RO	Stores the MAC address of the given network interface.
GevCurrentIPConfigurationLLA	Boolean		RW	Indicates if Link Local Address IP configuration scheme is activated on the given network interface.
GevCurrentIPConfigurationDHCP	Boolean		RW	Indicates if DHCP IP configuration scheme is activated on the given network interface.
GevCurrentIPConfigurationPersistentIP	Boolean		RW	Indicates if PersistentIP configuration scheme is activated on the given network interface
GevCurrentIPAddress	Integer		RO	Reports the IP address for the given network interface once it has been configured
GevCurrentSubnetMask	Integer		RO	Provides the subnet mask of the given interface
GevCurrentDefaultGateway	Integer		RO	Indicates the default gateway IP address to be used on the given network interface
GevPersistentIPAddress	Integer		RW	Indicates the Persistent IP address for this network interface

Parameter Name	Type	Value	Access	Description								
GevPersistentSubnetMask	Integer		RW	This feature indicates the Persistent subnet mask associated with the Persistent IP address on this network interface.								
GevPersistentDefaultGateway	Integer		RW	Indicates the persistent default gateway for this network interface.								
GevLinkSpeed	Integer		RO	Indicates the speed of transmission negotiated by the given network interface in Mbps.								
GevCCP	Enumeration	<table border="1"> <thead> <tr> <th>String</th> <th>Num.</th> </tr> </thead> <tbody> <tr> <td>OpenAccess</td> <td>0</td> </tr> <tr> <td>ExclusiveAccess</td> <td>1</td> </tr> <tr> <td>ControlAccess</td> <td>2</td> </tr> </tbody> </table>	String	Num.	OpenAccess	0	ExclusiveAccess	1	ControlAccess	2	RO	
String	Num.											
OpenAccess	0											
ExclusiveAccess	1											
ControlAccess	2											
GevPrimaryApplicationSocket	Integer		RO	Indicates the UDP source port of the primary application.								
GevPrimaryApplicationIPAddress	Integer		RO	Indicates the address of the primary application.								
GevMCPHostPort	Integer		RW	Controls the port to which the device must send messages. Setting this value to 0 closes the message channel.								
GevMCDA	Integer		RW	Controls the destination IP address for the message channel.								
GevMCTT	Integer		RW	Provides the message channel transmission timeout value in milliseconds.								
GevMCRC	Integer		RW	Controls the number of retransmissions allowed when a message channel message times out.								
GevMCSP	Integer		RO	Indicates the source port for the message channel								
GevSCCFGUnconditionalStreaming	Boolean		RW	Enables the camera to continue to stream, for this stream channel, if its control channel is closed or regardless of the reception of any ICMP messages (such as destination unreachable messages).								

Parameter Name	Type	Value	Access	Description
GevSCPHostPort	Integer		RW	Indicates the port to which the device must send data stream.
<i>GevSCPSFireTestPacket</i>	Boolean		RW	When this bit is set, the device fires one test packet.
<i>GevSCPSDoNotFragment</i>	Boolean		RW	This bit is copied into the <i>do not fragment</i> bit of the IP header of each stream packet.
GevSCPD	Integer		RW	Indicates the delay (in timestamp counter unit) to insert between each packet for this stream channel.
<i>GevSCDA</i>	Integer		RW	Indicates the destination IP address for this stream channel.
<i>GevSCSPacketSize</i>	Integer	Min: 72 Max: 8164	RW	The stream packet size to send on this channel, except for data leader and data trailer; and the last data packet which might be of smaller size (since packet size is not necessarily a multiple of block size for stream channel).
GevHeartbeatTimeout	Integer	Min: 500 Max: 4294967295	RW	Indicates the current heartbeat timeout in milliseconds.
GevTimestampTickFrequency	Integer		RO	This 64-bit feature indicates the number of timestamp ticks during 1 second.
GevTimestampControlLatch	Command		WO	Latches current timestamp counter into Timestamp Value register.
GevTimestampControlReset	Command		WO	Resets timestamp 64-bit counter to 0.
GevTimestampValue	Integer		RO	Reports the latched 64-bit value of the timestamp counter.

User Set Control

User Set Control allows you to save custom settings and reload them into the camera as needed.

Parameter Name	Type	Value		Access	Description
<i>UserSetSelector</i>	Enumeration	String	Num.	RW	Selects User Set to load, save, or configure. Default settings are configured by the factory and are write-protected
		Default	0		
		UserSet0	1		
		UserSet1	2		
		UserSet2	3		
UserSet3	4				
<i>UserSetLoad</i>	Command			WO	Loads User Set specified by <i>UserSetSelector</i> from non-volatile memory into camera RAM and makes it active.
<i>UserSetSave</i>	Command			WO	Saves User Set 0, 1, 2 or 3 specified by <i>UserSetSelector</i> to non-volatile memory.
<i>UserSetDefault</i>	Enumeration	String	Num.	RW	Selects User Set to load and activate when a camera is powered on or reset. Default Configuration is set by the factory.
		Default	0		
		UserSet0	1		
		UserSet1	2		
		UserSet2	3		
UserSet3	4				

Configuring an Ethernet Adapter and Host Computer

For the best system performance, configure the following parameters of your network interface card (NIC): Jumbo Frames (Jumbo Packets), Receive/Transmit Buffers, Interrupt Moderation Rate to the values shown below. You also might need to disable antivirus software and Firewalls, turn off power saving plan, and configure IP addresses for multiple NICs on the host computer.



Make sure that the version of your NIC driver is the most recent one, update it if necessary. Using an outdated version of a NIC driver might negatively affect the data transmission.

Parameter	Value
Jumbo Frames (or Jumbo Packets)	9000 (9014, 16K, or 9 KB MTU)
Receive Buffers (or Receiver Descriptors)	Maximum
Transmit Buffers	Maximum
Interrupt Moderation	Enable
Interrupt Moderation Rate (or Interrupt Throttling)	Extreme

For adjusting procedures, see the [Adjusting Jumbo Frames](#), [Receive/Transmit Buffers](#), and [Interrupt Moderation Rate in Windows](#) section.

NOTE ⚠ The parameter names and configuring procedures depend on the adapter model and manufacturer and may differ from the ones described in this chapter. When adjusting the adapter parameters, select the ones that relate to the parameters listed above. For more information, refer to the NIC documentation.

Jumbo Frames

Jumbo Frames (or **Jumbo Packets**) parameter allows for payloads larger than the standard maximum transmission unit (MTU) of 1,500 bytes and supports up to 9,000 bytes per packet. Jumbo Frames are used to reduce the overhead load per packet, decrease CPU load, and increase data transfer rate. As fewer packets are needed to transfer data, the number of interrupts decreases resulting in lower overall CPU usage.

Make sure that all network equipment (cameras, switches, routers, Network Interface Cards (NICs)) supports Jumbo frames and is configured to use the same frame size. If some network devices do not support Jumbo Frames, then packets and frame drops may occur.

Most network adapters have Jumbo Packets disabled. To enable Jumbo Packet, please follow the steps in the [Adjusting Jumbo Frames, Receive/Transmit Buffers, and Interrupt Moderation Rate in Windows](#) section.

TIP ⓘ

Connect the Cheetah 10 GigE Vision camera to a dedicated Ethernet port and use an Ethernet adapter that supports Jumbo Packets.

Receive/Transmit Buffers

Receive Buffers (or **Receive Descriptors**) and **Transmit Buffer** parameters set the amount of system memory that can be used by the adapter driver when copying data to the memory. Typically, it is set to a low value by default (usually 256). This insufficient number of receive/transmit buffers leads to dropped packets (older packets will be overwritten).

For maximum performance, set these parameters as high as possible.

The maximum setting supports more packets, improves stability, and can be configured on the most systems without causing any system level interrupt. However, it can negatively affect servers which have limited system memory.

NOTE ⚠

Receive/Transmit Buffers settings do not affect your system's CPU usage.

TIP ⓘ

The Receive Buffers can be set up to 2048 depending upon the RAM available. Make sure that the Transmit Buffers setting is double the Receive Buffers. Experiment with the settings until you achieve the best value appropriate for your system.

Interrupt Moderation Rate

Interrupt Moderation Rate (or **Interrupt Throttling**) sets the maximum number of interrupts per second to the CPU when processing the transmitted and received packets.

Minimizing the interval between interrupts reduces the latency on each packet but increases CPU usage and decreases throughput. To minimize CPU usage, larger interrupt intervals are required.

Some NICs support only Interrupt Moderation control, while the others support both Interrupt Moderation and Interrupt Moderation Rate control.

When the Interrupt Moderation setting is disabled, an interrupt is created for every packet, reducing the latency on each packet. However, this significantly increases CPU usage. Enabling the Interrupt Moderation setting allows multiple packets to be processed for each interrupt lowering CPU usage.

TIP ⓘ

The Interrupt Moderation Rate can be set at about 8,000 (or Extreme) interrupts per second to achieve lower latency.

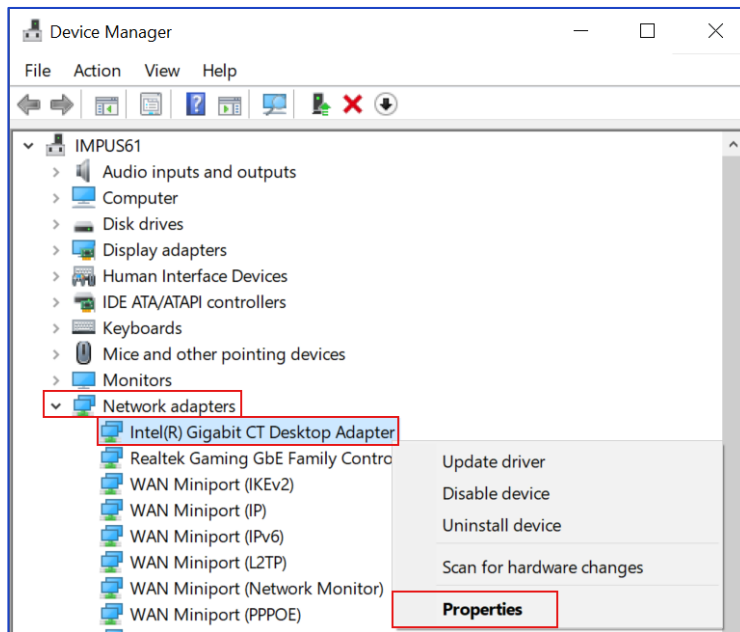
If some latency is acceptable, the Interrupt Moderation Rate can be set at about 1,000 (or Low) interrupts per second to achieve lower CPU usage.

Experiment with your system to determine the optimal setting. You can try the following options as well:

- Use the default value set by the manufacturer's drivers.
- Set a NIC to the adaptive interrupt moderation mode. In this mode, the interval is dynamically changed according to packet size and throughput.

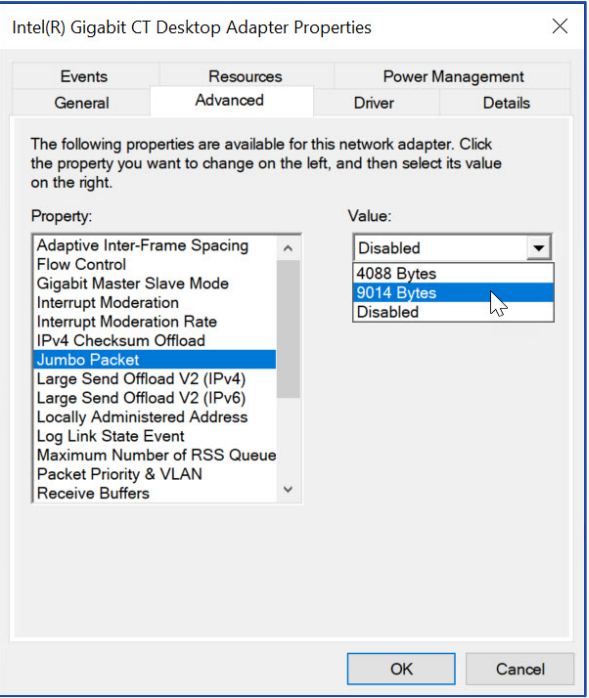

Adjusting Jumbo Frames, Receive/Transmit Buffers, and Interrupt Moderation Rate in Windows

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Hardware and Sound** → **Devices and Printers** → **Device Manager**.
3. Expand **Network Adapters** list → Right-click the Ethernet adapter that works with your camera → **Properties**.



4. On the **Advanced** tab, set the following parameters:
 - **Jumbo Packet** (or **Jumbo Frame**) → Set **Value** to *9014 Bytes* (or *9 KB MTU, 9000, 16K* – depends on NIC).
 - **Receive Buffers** (or **Receive Descriptors**) → Set to the maximum value possible.
 - **Transmit Buffers** → Set to the maximum value possible.
 - **Interrupt Moderation** → *Enable*.
 - **Interrupt Moderation Rate** (or **Interrupt Throttling**) → Set to *Extreme*.
At higher data rates, the Extreme setting may improve system performance. At lower data rates, a Low setting is preferred since delayed interrupts cause additional latency.

If **Jumbo Packet** or **Jumbo Frame** is absent from the list, your NIC does not support Jumbo Packets. Maximum camera performance cannot be achieved.



The screenshot shows the 'Intel(R) Gigabit CT Desktop Adapter Properties' dialog box with the 'Advanced' tab selected. The 'Property:' list on the left includes 'Jumbo Packet', which is highlighted. The 'Value:' dropdown on the right is open, showing options: 'Disabled', '4088 Bytes', '9014 Bytes', and 'Disabled'. A mouse cursor is pointing at '9014 Bytes'. The 'OK' and 'Cancel' buttons are at the bottom right.

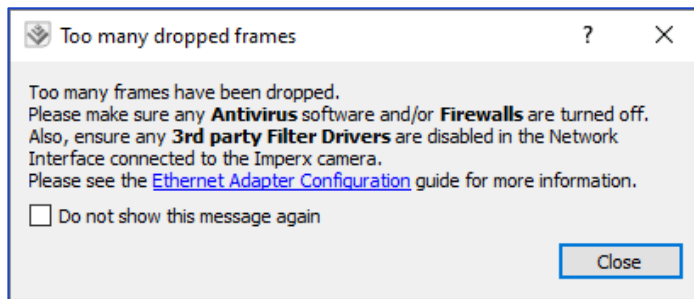
5. Click **OK**. The network connectivity may be lost for a couple of seconds.
6. Reboot your PC to ensure that new settings have been activated.

Configuring a Host Computer

This section describes how to disable the Windows Firewall, turn off the power saving plan, and configure IP addresses for multiple NICs on the host computer.

Antivirus software, Firewalls, or third-party filter drivers may impact the efficiency of the system resulting an excessive number of dropped frames and slow video streaming.

When too many frames have been dropped, the video acquisition rate slows down. The following pop-up window opens:



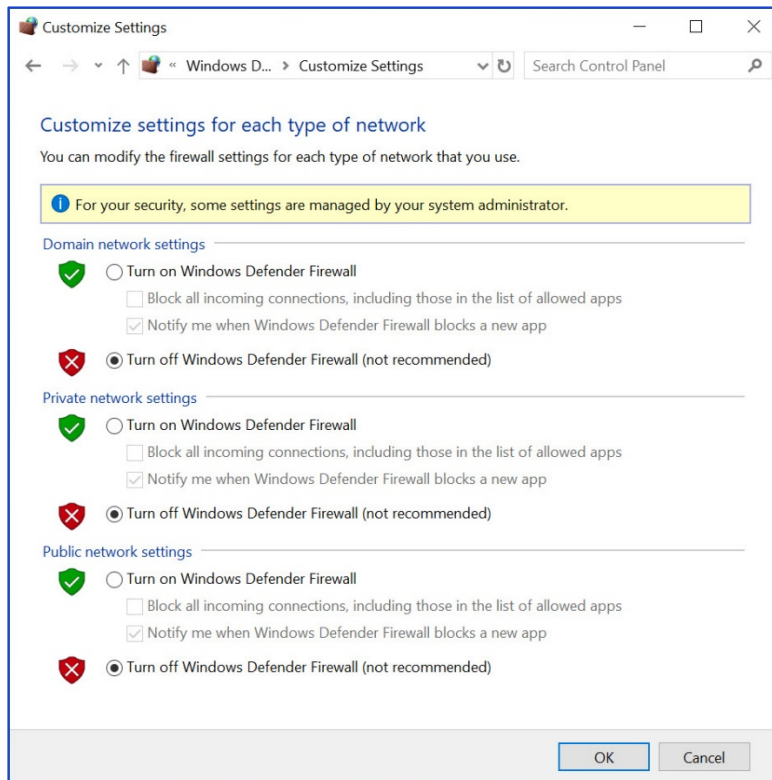
Imperx recommends **turning off** any Firewalls, antivirus software, and third-party filter drivers and to disable Windows Performance Monitor (perfmon.exe) or Wireshark (use it solely for debugging purposes), and not opening the Networking tab in Windows Task Manager.

To turn off the Firewall, please refer to the sections [Disabling Windows Firewall for All Connections](#) and [Disabling Windows Firewall for Selected Network Adapters](#).

Please contact your IT Department on turning off antivirus software and any third-party filter drivers.

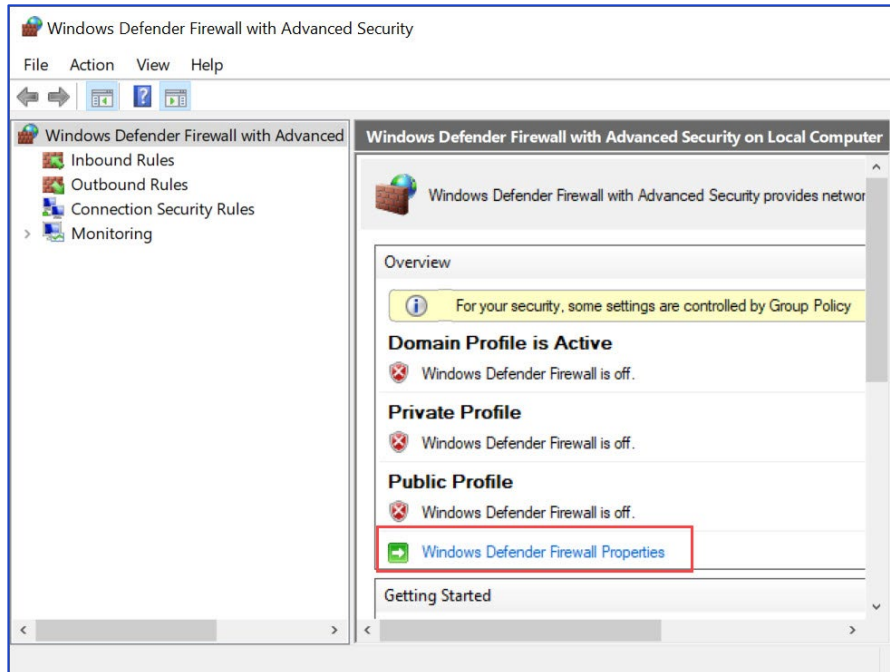
Disabling Windows Firewall for All Connections

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **System and Security** → **Windows Defender Firewall**.
3. On the left panel, click **Turn Windows Defender Firewall on or off**. The **Customize settings** windows opens.
4. Select a network type that your camera is connected to, and click **Turn off Windows Defender Firewall (not recommended)**. Click **OK**.

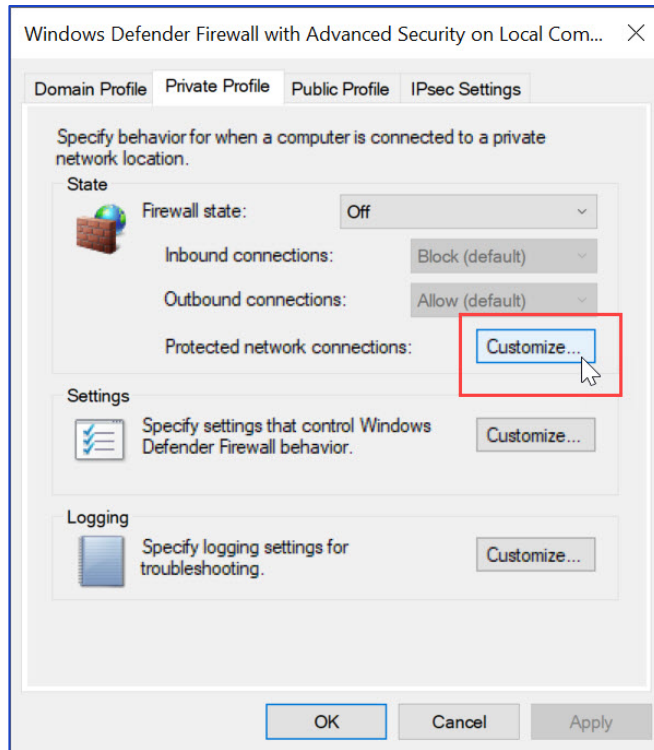


Disabling Windows Firewall for Selected Network Adapters

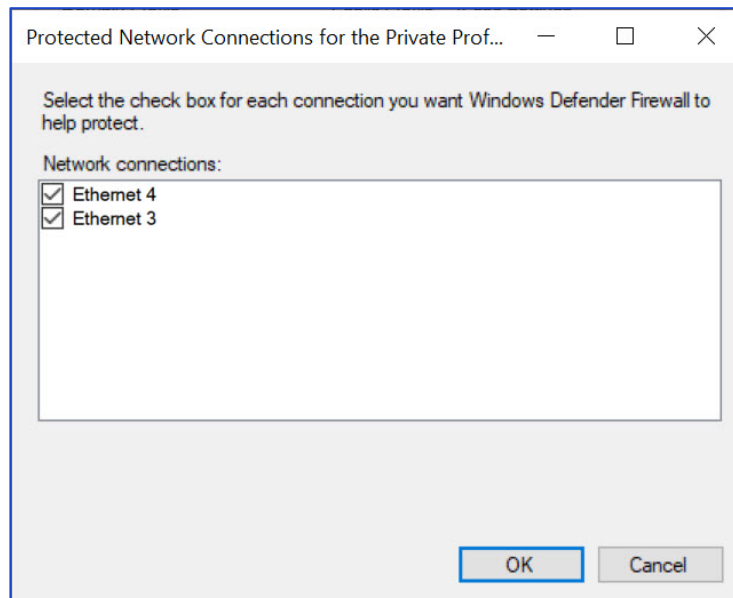
1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **System and Security** → **Windows Defender Firewall**.
3. On the left panel, click **Advanced settings**. The **Windows Defender with Advanced Security** windows opens.
4. Click **Windows Defender Firewall Properties**.



5. In the **Windows Defender Firewall with Advanced Security on Local Computer Properties...** window, select the tab of the profile to turn off the firewall and click **Customize...** in the State section.



6. The **Protected Network Connections for the Private Profile** windows shows a list of the network connections with the firewall turned on. To disable the firewall, uncheck those connections that contain your cameras. Click **OK**.



Multiple NICs in a Single Host PC

When several NICs are installed in the same host PC, you have to assign a unique IP address to each NIC. You can use one of the following methods:

Method	When to use
Configuring a static IP address	In networks without a DHCP server
Configuring a dynamic IP address via DHCP	In networks with a DHCP server installed
Link-Local IP Addressing	In the absence or failure of static or dynamic address configuration

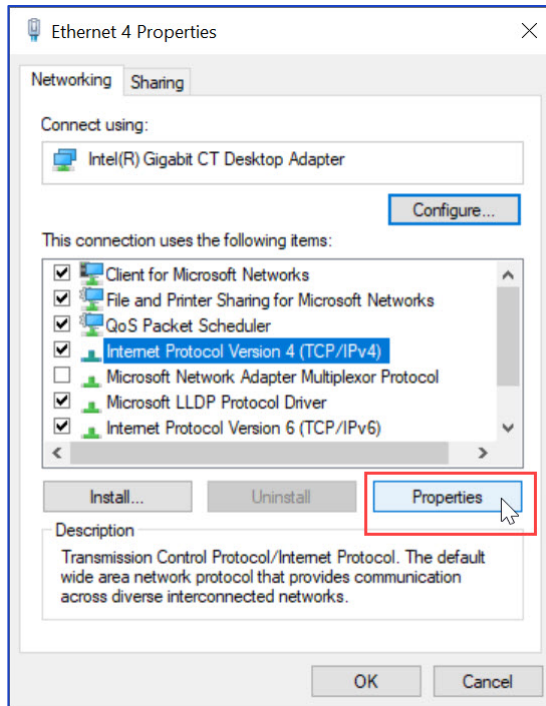
TIP

Before assigning a dynamic IP address, please make sure that a DHCP server is installed in your network. The DHCP server assigns the IP address to each NIC with DHCP/Auto IP setting enabled.

If the DHCP server is not installed in the network, manually assign static IP addresses to each NICs and GigE Vision cameras.

Configuring a Static IP Address in Windows

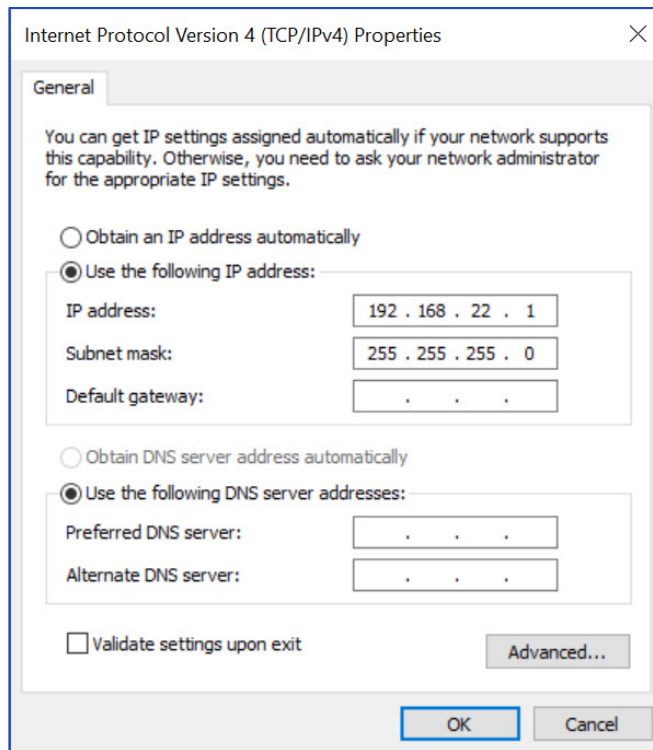
1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Network and Internet** → **Network and Sharing Center**.
3. On the left panel, click **Change adapter settings**.
4. Right-click the Ethernet adapter that works with your camera → **Properties**.
5. Select Internet **Protocol Version 4 (TCP/IPv4)**, click **Properties**.



6. Select **Use the following IP address** and assign an IP address to the network adapter. The **Default gateway** field should be blank.

Imperx recommends using a private network IP address. The following IPv4 address ranges are reserved for private networks:

RFC1918 name	IP address range	Largest CIDR block (subnet mask)
24-bit block	10.0.0.0–10.255.255.255	10.0.0.0/8 (255.0.0.0)
20-bit block	172.16.0.0–172.31.255.255	172.16.0.0/12 (255.240.0.0)
16-bit block	192.168.0.0–192.168.255.255	192.168.0.0/16 (255.255.0.0)

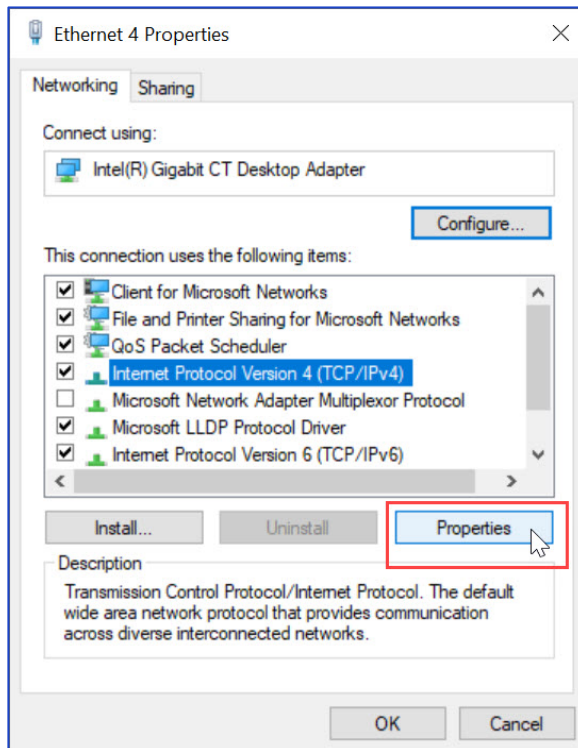


7. Click **OK**.
8. Repeat steps 4–6 for each NIC on your computer.

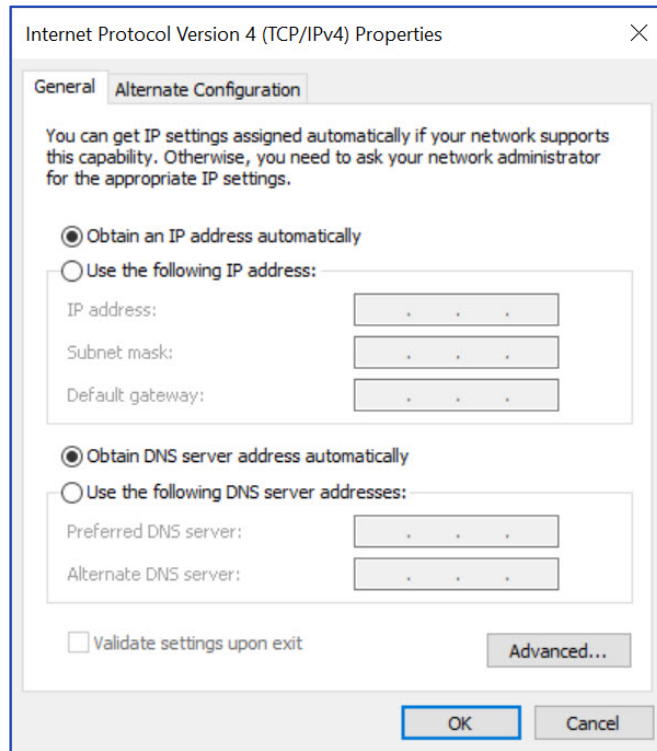
Configuring a Dynamic IP Address via DHCP in Windows

For a NIC to obtain an IP address automatically, follow the steps below.

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Network and Internet** → **Network and Sharing Center**.
3. On the left panel, click **Change adapter settings**.
4. Right-click the Ethernet adapter that works with your camera → **Properties**.
5. Select Internet **Protocol Version 4 (TCP/IPv4)**, click **Properties**.



6. Make sure that **Obtain an IP address automatically** is enabled.



NOTE ⚠ The DHCP server assigns a dynamic IP address to the NIC. If the DHCP server is not available, a link-local address assignment takes place.

Link-Local IP Address

A NIC assigns a link-local IP address automatically when a static IP address has not been configured and a DHCP is not enabled. This address is valid only for a local network and is not routable.

The IPv4 address range is 169.254.0.0–169.254.255.255.

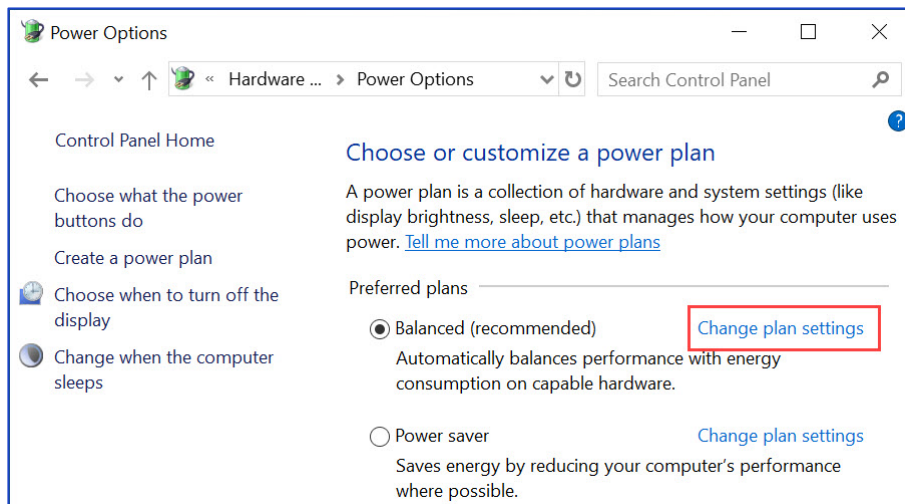
When a static IP address or DHCP becomes available, a new IP address is assigned instead of the link-local address.

Configuring Power Management in Windows

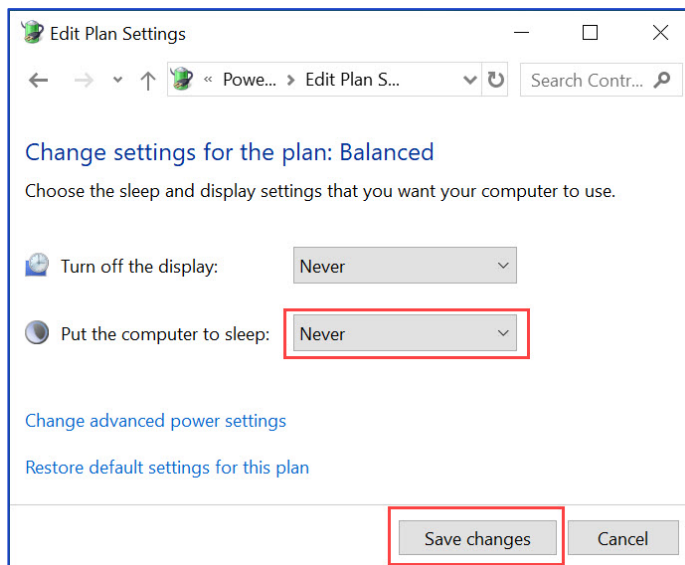
For applications with extended periods of image streaming, configuring power management is required. Typically, if there is no activity from the keyboard or mouse, the computer or NIC goes to sleep, and the image stream gets interrupted. To prevent Windows from powering down the NIC or computer, you need to change the power plan settings.

To change power plan settings for the computer:

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Hardware and Sound** → **Power Options**.
3. Next to the power plan, click **Change plan settings**.

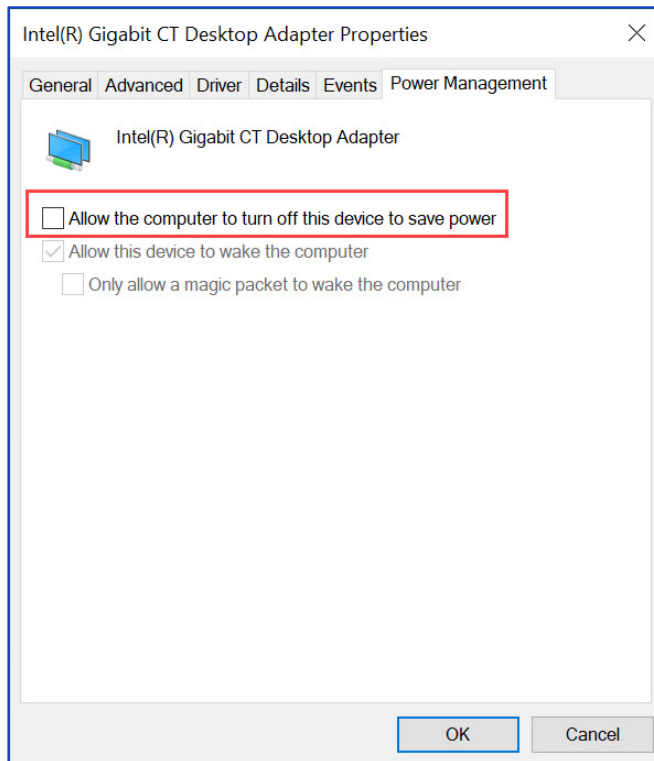


4. In the **Put the computer to sleep** dropdown list select **Never** and click **Save changes**. **Turn off display** can be set to any value.



To change power plan settings for the NIC:

1. Click **Start** icon → **Windows System** → **Control Panel**.
2. Click **Network and Internet** → **Network and Sharing Center**.
3. On the left panel, click **Change adapter settings**.
4. Right-click the Ethernet adapter that works with your camera → **Properties**.
5. Click **Configure**. Adapter Properties window opens.
6. On the **Power Management** tab, uncheck the **Allow the computer to turn off this device to save power** option, click **OK**.
7. Repeat steps 4–6 for each NIC.

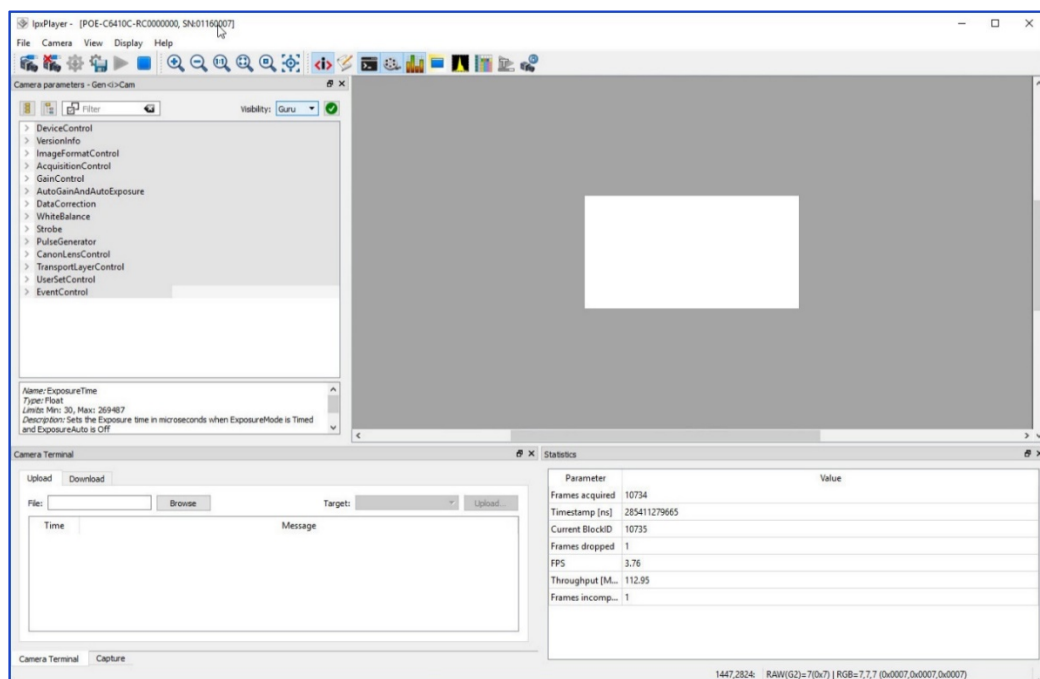


Software GUI

Overview

The IpxPlayer software application provides a graphical user interface (GUI) with functionality for controlling Imperx camera parameters, acquiring video, showing acquired video, and saving acquired images or video on the host computer.

The application also collects and displays statistical information on acquired images and generates a log of data transfers between the camera and the host computer.



Supported Operating Systems

The IpxPlayer is compatible with the following operating systems:

- Windows 7, 32-bit and 64-bit
- Windows 10, 32-bit and 64-bit
- Ubuntu Linux 18.04 64-bit
- Ubuntu Linux 18.04 64-bit, ARM CPU
- Ubuntu Linux 20.04 64-bit

Compatibility

The IpxPlayer is compatible with the Imperx GigE Vision cameras.

User Interface and Functionality

The IpxPlayer provides the following functionalities:

- Detects camera.
- Connects to the camera and will run multiple instances of applications.
- Controls camera parameters (gain, exposure, trigger, white balance, and so on) using the GenICam node tree GUI.
- Logs all protocol-related data (commands, images, events, and so on) transferred between the camera and host computer.
- Shows live video from the selected camera.
- Saves acquired video images or a series of images to a file.
- Saves and loads camera configuration files.

Installing the Software

Use the installation wizard to install the Imperx Camera SDK software supplied with your camera.



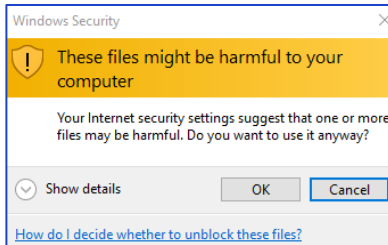
If a previous version of the GUI software is installed on your computer, you must remove it before completing the installation. The installation wizard will do this for you during the installation process. Or, you can uninstall a previous version yourself.

To remove previous versions yourself:

1. Open **Control Panel** on your computer.
2. Select **Programs and Features**.
3. Select the software from the list.
4. Click **Uninstall**.

Installation

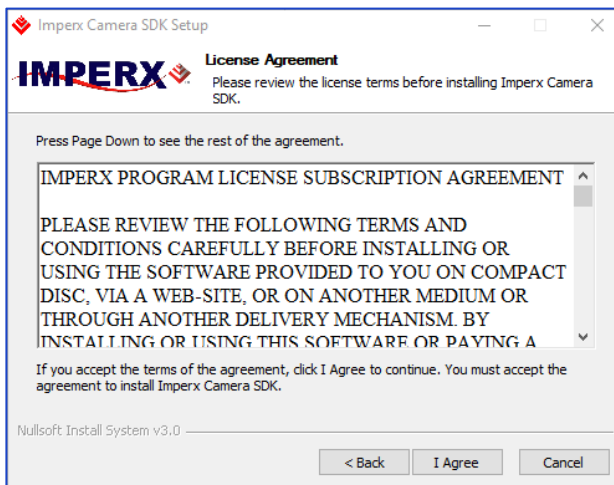
1. Locate the executable file (IpxCameraSdk***.exe) on the media that shipped with your camera.
2. Drag the file to your computer desktop. If a Security screen appears, click **OK**.



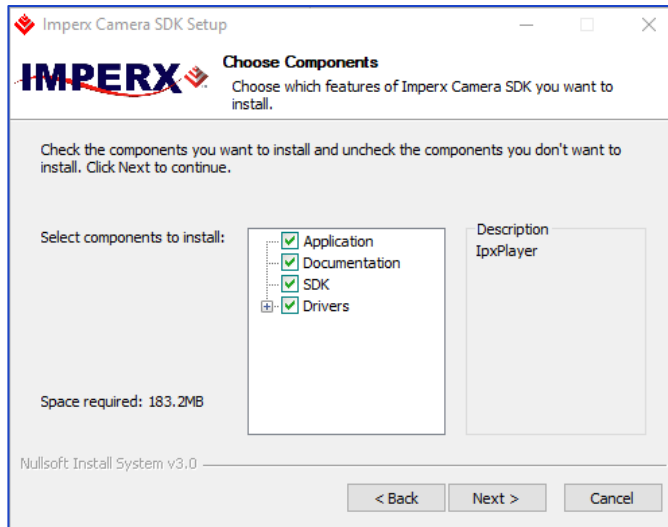
3. Double click the executable file (IpxCameraSdk***.exe) on your desktop. The Welcome Setup screen opens. Note the recommendation to close other applications and click **Next**.



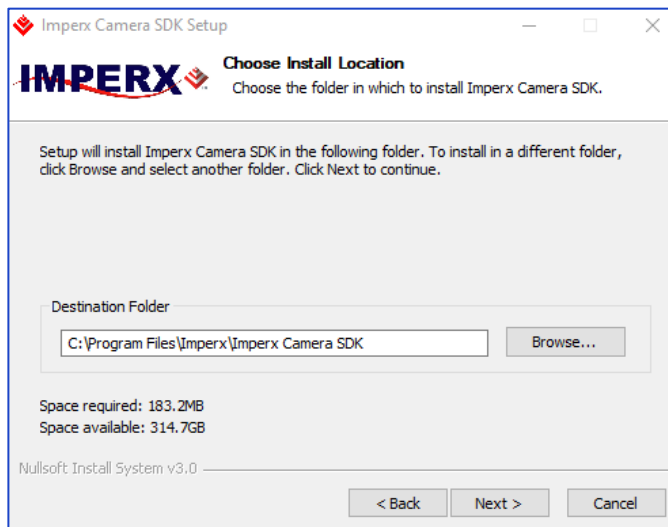
4. When the License Agreement screen appears, read the agreement and click **I Agree**.



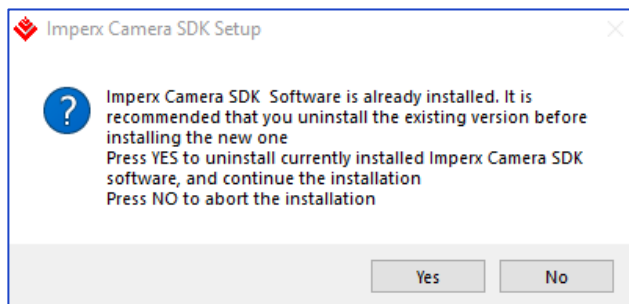
5. On the Choose Components screen, select all the Cheetah Camera SDK components and click **Next**.



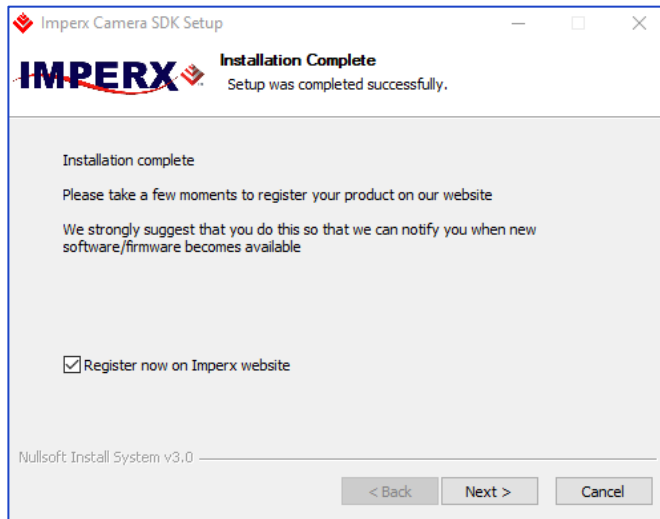
- On the Choose Install Location screen, accept the default destination folder or click **Browse** and select a different location, click **Next** and then **Install**.



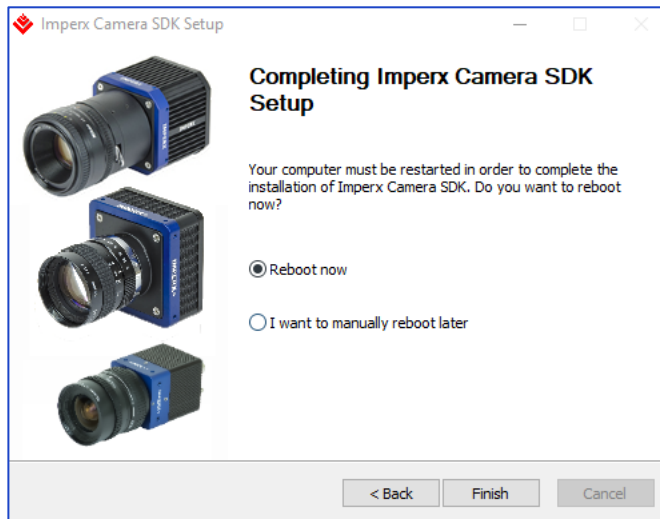
The installer prompts you to uninstall any existing versions of the software from your computer before continuing the installation.



- On the Installation Complete screen, select the check box to register your software and click **Next**. When the Imperx website appears, complete the Subscriber Registration and click **Submit**.



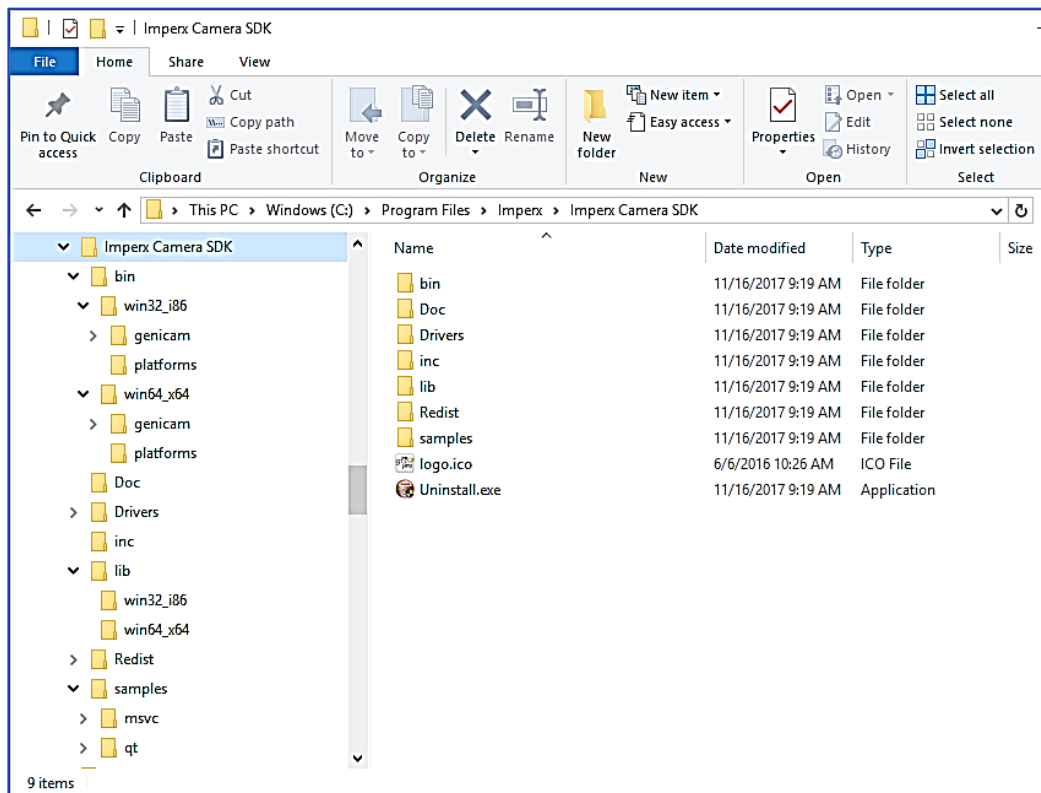
- On the Completing Imperx Camera SDK Setup screen, select Reboot now and click **Finish**. The Imperx IpxPlayer icon appears on your desktop.



Camera SDK

The installation process places the Imperx camera SDK files on your computer's hard drive using following structure:

<InstallationFolder> – root SDK folder (usually, on the Windows OS, it is C:\Program Files\Imperx\Imperx Camera SDK\).



<InstallationFolder> \bin\ – contains SDK binary executable files, including SDK dynamic libraries and IpxPlayer application executable

<InstallationFolder> \Doc\ – contains SDK user manual files


<InstallationFolder> \inc\ – contains SDK C++ header files

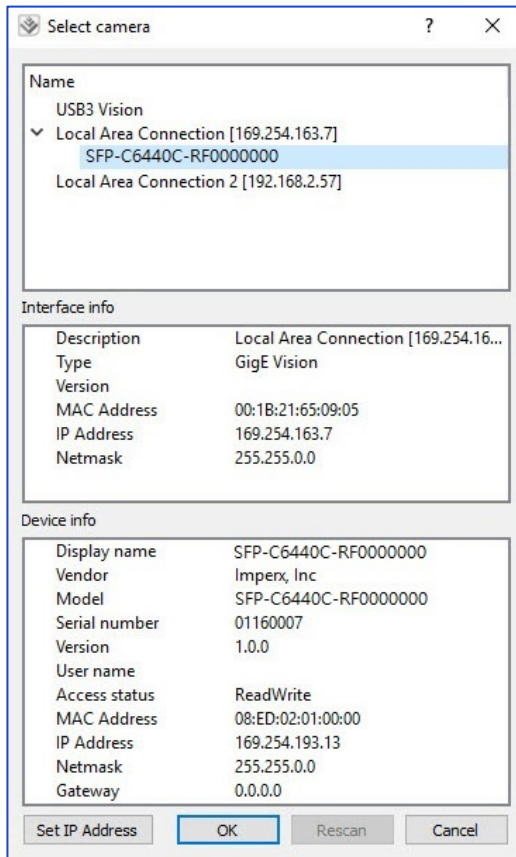
<InstallationFolder> \lib\ – contains SDK C++ library files

<InstallationFolder> \samples\ – contains SDK C++, C#, Python samples

<InstallationFolder> \Drivers\ – contains kernel drivers for Imperx USB3 cameras

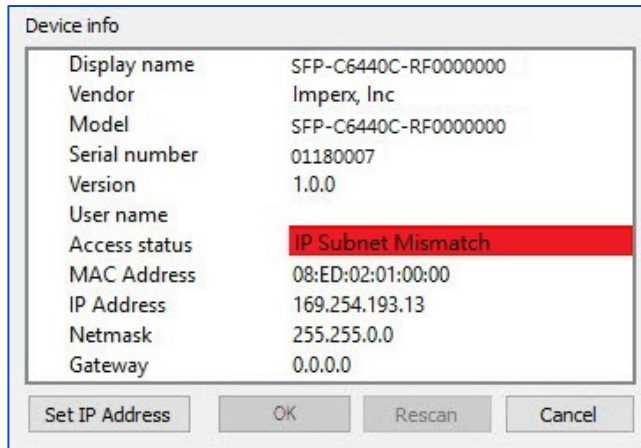
Connecting to Cameras


1. Locate and open the IpxPlayer from your desktop.
2. Click **Camera** menu and select **Connect** (or click the camera icon ).
The Select Camera dialog appears. The dialog lists all connected cameras. The version number refers to the installed Imperx GUI driver.
3. Select a camera listed on the dialog.
Camera information appears in the Device info section of the dialog.
4. Click **OK**. If needed, click **Rescan** to update the list of cameras.



TIP

The first time you attempt to connect to the camera, you might need to set the IP address if IP Subnet Mismatch appears highlighted in red and the OK button is not available.

**To Set the IP Address:**

1. Click **Set IP Address**.
2. When the Set IP Address screen appears, click **OK**.
3. On the Select Camera screen, click **OK**.
4. After the camera connects, click the play  icon on the IpxPlayer to begin capturing and displaying images.



Using the IpxPlayer

The IpxPlayer displays and controls camera features and attributes based on an XML file stored in Flash memory inside the camera. The main window provides access to menus, shortcut icons, camera parameters, live images, capture options, a log, and camera statistics. You can customize the screen by closing, resizing, or hiding certain sections. Click **Log** at the bottom of the screen to see recent data transfers to or from the connected camera.









Menu Bar

The menu bar provides File, Camera, View, and Display options. Icons below the menu bar provide quick access to many of the menu bar functions. You can display an icon's function by rolling the computer cursor over it.






File Menu




Load Configuration		Opens the Open File dialog for loading a Camera Configuration file.
Save Configuration		Saves changes to an opened configuration file.
Save Configuration As		Opens the Save File dialog for saving the Camera Configuration file with a user-specified file name.
Exit		Closes the application.

Camera Menu







Connect		Opens the Connection dialog for connecting to a camera.
Disconnect		Disconnects the camera.
Camera Information		Displays Camera Information including model, version, sensor type, firmware version, XML version, and so on.
Play		Starts live video.
Bandwidth testing		Allows you to find the optimal Pixel Clock value for given USB3 interface bandwidth
Stop		Stops live video.
Record		Toggles video recording start/stop on the computer's hard drive.
Snap		Captures one image and saves it to the computer's hard drive.

View Menu

GenICam Tree		Shows/hides the camera control GenICam tree panel.
Log		Shows/hides the camera control Log panel (Control, Stream, Events).
Camera Terminal		Shows/hides the Camera Terminal panel. Use this panel for uploading Firmware Updates, LUT, FFC, DPC/HPC files or downloading LUT, FFC, DPC/HPC files.
Capture		Shows/hides the Capture panel.
Statistics		Shows/hides the Statistics panel.

Inspection View		Opens a window showing a portion of the image. Use Inspection View sliders to reposition the view of your image. Drag to reposition the window.
Histogram		Shows/hides the Histogram panel.
Hex Pixel Dump		Shows/hides the Hex Pixel Dump panel. Use this panel for pixel analysis.

Display Menu

Zoom IN		Increases the zoom by 25 percent around the center of the image when clicked.
Zoom OUT		Decreases the zoom by 25 percent around the center of the image when clicked.
Actual Size (100%)		Sets zoom to 1:1 in the center of the image.
Fit to Window		Scales the image to fit within the window height while maintaining aspect ratio.
Spread to Window		Scales the image width to fit across the display window while maintaining the image aspect ratio.
Center Image		Moves the center of the image to the center of display window.

Saving and Loading Configurations

The File menu provides a **Save As** function for configuration changes made in the camera parameters section of the screen. Saved configurations on the host computer have a file extension of `.iccf`.

You can share these files with other users by email and other file transfer methods. You can load saved configurations into the IpxPlayer at any time.

To save a configuration:

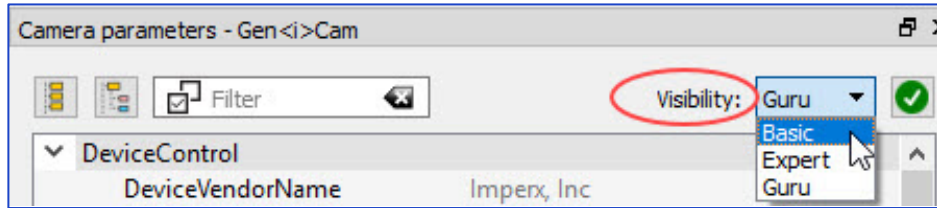
1. Select the **File** menu.
2. Select **Save Configuration as**.
3. Navigate to location on your host computer.
4. Create a file name.
5. Click **Save**.

To load a configuration:

1. Select the **File** menu.
2. Select **Load Configuration**.
3. Navigate to the folder containing the file.
4. Click **Open**.

Camera Parameters Panel

The GenICam node tree displays the camera’s available configuration parameters. Use the Visibility drop-down to select an access level of Basic, Expert, or Guru.



- Basic** Provides visibility of all the basic features of the camera.
- Expert** Provides visibility of advanced features of the camera that require a more in-depth knowledge of the camera functionality. This is the preferred visibility level for all advanced features in the cameras.
- Guru** Provides visibility of more advanced features that, if set incorrectly, might cause the camera to work improperly.

Device Control Category

The Device Controls parameters provide information about the camera.

DeviceControl	
DeviceVendorName	Imperx, Inc
DeviceModelName	SFP-C6440C-RL0000000
DeviceVersion	1.0.0
DeviceFirmwareVersion	v1403b0043
DeviceManufacturerInfo	Support: 1-561-989-0006
DeviceSerialNumber	01180055
DeviceUserID	
DeviceSFNCVersionMajor	2
DeviceSFNCVersionMinor	3
DeviceSFNCVersionSubMinor	0
DeviceScanType	Areascan
DeviceReset	Execute
CameraHeadReset	Execute
SensorTemperature	38.68°C
SensorBoardTemperature	35.00°C
FPGATemperature	53.00°C
FPGABoardTemperature	46.00°C

- DeviceVendorName** Imperx, Inc.
- DeviceModelName** Full camera part number.
- DeviceVersion** Camera Hardware version.
- DeviceManufactureInfo** Technical support: 1-561-989-0006

DeviceSerialNumber	Camera serial number.
DeviceUserID	User-defined camera name.
DeviceSFNCVersionMajor	The major version number of the GenICam Standard Features Naming Convention.
DeviceSFNCVersionMinor	The minor version number of the GenICam Standard Features Naming Convention.
DeviceSFNCVersionSubMinor	The sub major version number of the GenICam Standard Features Naming Convention.
DeviceScanType	Scan type of the sensor.
DeviceReset	Resets the entire camera, including communications.
CameraHeadReset	Resets only the image sensor to default.
SensorTemperature	Current sensor temperature.
SensorBoardTemperature	Current sensor board temperature.
FPGATemperature	Current FPGA temperature.
FPGABoardTemperature	Current FPGA board temperature.

Temperature Control Category

You to set the fan’s operation mode and the temperature at which the fan turns on in Auto mode.

▼ TemperatureControl	
FanMode	On
FanOnTemperature	50°C

FanMode	Selects the operation mode of the camera fan.
FanOnTemperature	Sets the temperature, in Celsius degrees, when the camera fan turns on to cool the camera (in Auto mode). Fan turns off when the internal camera temperature is 4 °C below the set temperature.

Version Info Category

The camera contains non-volatile memory that stores manufacturing related information. The factory programs this information during the manufacturing process.

VersionInfo	
SensorType	Monochrome
SensorModel	IMX342LL
RgsID	A000
FirmwareImage	A
CameraHeadFirmwareVersion	2
CameraHeadFirmwareBuild	5
FirmwareVersion	100
FirmwareBuild	30
CustomerID	0
FamilyID	22
XmlVersion	10102

SensorType	Returns the CMOS sensor type: Bayer Color or Monochrome
SensorModel	Returns the CMOS sensor model.
RgsID	The camera's register ID number.
FirmwareImage	The Firmware Image ID (F=Factory or A=Application).
CameraHeadFirmwareVersion	The Firmware version number.
CameraHeadFirmwareBuild	The Firmware build number.
CustomerID	The Customer ID for custom firmware (0=Imperx standard firmware).
FamilyID	The Family ID.
XmlVersion	The version of the XML file.

Image Format Control Category

Provides information on the camera base resolution and output resolution.

ImageFormatControl	
SensorWidth	6480
SensorHeight	4860
WidthMax	6464
HeightMax	4860
Width	6464
Height	4860
OffsetX	0
OffsetY	0
PixelFormat	Mono8
PixelSize	Bpp8
Pixel Color Filter	None
BinningVertical	1
BinningHorizontal	1
DecimationVertical	1
DecimationHorizontal	1
ReverseX	False
ReverseY	False
TestPattern	Off
SensorTestPattern	Off
AdcBitDepth	Bit10
SensorShutterMode	Global

SensorWidth Effective width of the sensor in pixels.

SensorHeight Effective height of the sensor in pixels.

WidthMax Maximum width of the image in pixels calculated after horizontal binning, decimation, or any other functions change horizontal dimension of image.

HeightMax Maximum height of image in pixels calculated after vertical binning, decimation, or any other functions change vertical dimension of image.

Width Allows you to create an AOI: sets the output image width in number of pixels (multiples of 32).

Height Allows you to create an AOI: sets the output image height in number of lines (multiples of 4).

OffsetX AOI Offset in horizontal dimension: Enter the number of pixels to offset the image output from the left edge of the image. The number must be a multiple of 32.

OffsetY AOI Offset in the vertical dimension: Enter the number of pixels to offset the image output from the top of the image. . The number must be a multiple of 4.

PixelFormat The number of bits of memory associated with each pixel. Options are: Mono8, Mono10, Mono10Packed, Mono12, Mono12Packed, BayerGR8, BayerRG8, BayerGB8, BayerBG8, BayerGR10, BayerRG10, BayerGB10, BayerBG10, BayerGR12, BayerRG12, BayerGB12, BayerBG12, BayerGR10Packed, BayerRG10Packed, BayerGB10Packed, BayerBG10Packed, BayerGR12Packed, BayerRG12Packed, BayerGB12Packed, BayerBG12Packed.

PixelSize	Number of bits per pixel in memory (8-, 10-, or 12-bits).
PixelColorFilter	Shows the color filter pattern.
BinningVertical	Sets number of rows to combine.
BinningHorizontal	Sets number of columns to combine.
DecimationVertical	Sets number of rows to skip.
DecimationHorizontal	Sets number of columns to skip.
ReverseX	Horizontally flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
ReverseY	Vertically flips the image output. Any area of interest is applied after the flipping. The <i>PixelFormat</i> of color cameras changes automatically.
TestPattern	Enables test patterns based on the following selections: GreyHorizontalRamp, GreyVerticalRamp, GreyHorizontalRampMoving, GreyVerticalRampMoving, FlatField.
SensorTestPattern	Selects the type of test pattern that is generated by the camera image sensor.
ADCBitDepth	Returns which ADC bit depth is used. A higher ADC bit depth results in better image quality but slower maximum frame rate.
SensorShutterMode	Returns the shutter mode of the device.

Acquisition Control Category

Acquisition Control determines the data flow between the camera and the computer.

▼ AcquisitionControl	
AcquisitionMode	Continuous
AcquisitionStart	Execute
AcquisitionStop	Execute
AcquisitionAbort	Execute
AcquisitionFrameCount	1
ExposureMode	Timed
ExposureTime	25564µs
ExposureAuto	Off
AcquisitionFrameRateEnable	False
AcquisitionFrameTime	28177
AcquisitionFrameRate	35.49Hz
AcquisitionLineTimeEnable	False
AcquisitionLineTime	423
AcquisitionBurstFrameCount	1
CurrentExposureTime	25564
CurrentFrameTime	28177
TriggerMode	Off
TriggerSoftware	Execute
TriggerSource	Line1
TriggerActivation	RisingEdge
TriggerOverlap	Off
TriggerDebounceTime	0
TriggerFilterTime	0
TriggerDelay	0

AcquisitionMode	Supports three modes of acquiring images: SingleFrame, MultiFrame, and Continuous.
AcquisitionStart	Starts the acquisition of the device.
AcquisitionStop	Stops the acquisition of the device at the end of the current frame.
AcquisitionAbort	Aborts acquisition immediately, but a partially transferred image will be completed. If acquisition is not in progress, command is ignored.
AcquisitionFrameCount	Lets you enter the number of frames to acquire when using the MultiFrame Acquisition mode.
ExposureMode	Sets the operation mode of the exposure. Options are: Off, Triggerwidth, Timed (refer to the section Exposure Control for more information).
ExposureTime	Sets the exposure time in microseconds when <i>ExposureMode</i> is Timed and <i>ExposureAuto</i> is Off.
ExposureAuto	Sets the automatic exposure mode when <i>ExposureMode</i> is Timed.

AcquisitionFrameRateEnable	Controls the acquisition frame rate/frame time. If this mode is On, you can extend frame time beyond the free-running frame time.
AcquisitionFrameTime	Allows you to set the actual frame time in microseconds. Changes to <i>AcquisitionFrameTime</i> affect the <i>AcquisitionFrameRate</i> setting.
AcquisitionFrameRate	Allows you to set the acquisition rate (in Hz with a precision of 0.01 Hz) at which the frames are captured. Changes to <i>AcquisitionFrameRate</i> affect the <i>AcquisitionFrameTime</i> setting.
AcquisitionLineTimeEnable	Controls the acquisition line time. If this mode is On, you can extend line time beyond the free-running line time.
AcquisitionLineTime	This feature sets the actual line time in pixel clocks (74.25MHz).
AcquisitionBurstFrameCount	Sets the number of frames to acquire for each trigger.
CurrentExposureTime	This is a read-only feature providing a real-time monitor of the camera exposure time in microseconds.
CurrentFrameTime	This is a read-only feature providing a real-time monitor of the camera output period in microseconds.
TriggerMode	Enables or disables the triggering operation. A trigger initiates an exposure then readout sequence. Triggers received prior to completion of this sequence are ignored.
TriggerSoftware	The Start SW Trigger command instructs the camera to generate one short trigger pulse to capture and read out one frame when <i>TriggerSource</i> is set to Software.
TriggerSource	Specifies the internal signal or physical input line to use as trigger source. Options are Line1, Line2, PulseGenerator, and Software (Software is a single frame capture using internal exposure setting).
TriggerActivation	Sets the triggering edge to Rising or Falling.
TriggerOverlap	Sets trigger overlap mode to Off (default). If the camera receives a trigger pulse while the previous trigger is still being processed, the camera ignores this pulse.
TriggerDebounceTime	Sets the trigger signal de-bounce time. Subsequent trigger signals coming to the camera within the de-bounce time interval are ignored.
TriggerFilterTime	Specifies the minimum Trigger signal pulse width. Any pulse shorter than the selected time is ignored.
TriggerDelay	Sets the delay time in microseconds between the trigger pulse and the start of exposure.

Analog Control Category

These parameters define analog and digital gain controls.

AnalogControl	
Gain	3.000000dB
GainAuto	Off
BlackLevel	60.000000
SensorBlackLevelRecommended	True
BlackLevelAuto	Continuous
DigitalGain	1.000000x
DigitalBlackLevel	0.000000
BalanceRatioSelector	Red
BalanceRatio	1.00
BalanceWhiteAuto	Off

- Gain** Sets analog/digital gain from 0 to 48 dB with 0.1 dB step.
- GainAuto** Sets the automatic gain control (AGC) mode. [ExposureMode](#) can be set to Timed, PulseWidth, or Off.
- BlackLevel** This represents a DC offset applied to the video signal. Values can range from 0 to 4095.
- SensorBlackLevelRecommended** Uses recommended value of *BlackLevel* from the sensor.
- BlackLevelAuto** Automatically adjusts the black level based on measurements of the dark reference lines at the start of each frame.
- DigitalGain** Sets digital gain from 1x to 4x.
- DigitalBlackLevel** Controls the Digital Black Level for all taps.
- BalanceRatioSelector** Selects which color will be impacted by the BalanceRatio control.
- BalanceRatio** Controls ratio of the selected color component to green, which is the reference color.
- BalanceWhiteAuto** Controls the mode for automatic white balancing between the color channels. The white balancing color ratios are automatically adjusted by selecting either Once or Continuous. If Off, the White Balance color ratios are set manually using BalanceRatioSelector and BalanceRatio controls.

Auto Algorithm Control Category

Auto Algorithm Control lets you configure settings for AWB (Automatic White Balance), AEC (Automatic Exposure Control), and AGC (Automatic Gain Control) algorithms.

You can set the camera to AEC/AGC to keep the same image brightness during changing lighting conditions. On the Auto Algorithm Control panel, you can configure the range of exposure times and gain values for AEC/AGC by placing minimum and maximum limits on these parameters.

▼ AutoAlgorithmControl	
BalanceWhiteAutoLowerLimit	0.250000
BalanceWhiteAutoUpperLimit	4.000000
BalanceWhiteAutoSpeed	64
ExposureAutoLowerLimit	50µs
ExposureAutoUpperLimit	25000µs
GainAutoLowerLimit	0.000000dB
GainAutoUpperLimit	48.000000dB
ExposureGainAutoPriority	ExposureTime
ExposureGainAutoMode	Average
ExposureGainAutoTarget	1500
ExposureGainAutoTargetThreshold	16
AverageLuminosity	1399
CurrentFrameCounterLow	79843
CurrentFrameCounterHigh	0
▼ ExposureAutoPIDCoefficients	
ExposureAutoPMin	0.040000x
ExposureAutoPMax	8.000000x
ExposureAutoExposureForPMax	25000µs
▼ GainAutoPIDCoefficients	
GainAutoPcoef	0.060000x
GainAutoIcoef	0.000000x
GainAutoDcoef	0.030000x

BalanceWhiteAutoLowerLimit Controls the minimum value AWB can set for the Red/Blue *BalanceRatio*.

BalanceWhiteAutoUpperLimit Controls the maximum value AWB can set for the Red/Blue *BalanceRatio*.

BalanceWhiteAutoSpeed Sets the speed of AWB algorithm. 1 is slowest, 64 is fastest.

ExposureAutoLowerLimit Sets the minimum exposure time value in microseconds.

- ExposureAutoUpperLimit** Sets the maximum exposure time value in microseconds.
- GainAutoLowerLimit** Sets the minimum gain when GainAuto is Continuous (step is 0.1 dB).
- GainAutoUpperLimit** Sets the maximum gain (up to 48 dB in 0.1 dB steps).
- ExposureGainAutoPriority** Selects whether to adjust gain or exposure first.
- ExposureGainAutoMode** Shows what luminance mode is used during AGC or AEC.
- ExposureGainAutoTarget** Sets the desired luminance level to be maintained during AGC or AEC or both assuming 12-bits per pixel.
- ExposureGainAutoTargetThreshold** Sets the acceptable steady-state error of the luminance level to be maintained during AGC or AEC. Normal initial setting for stability is 16.
- AverageLuminosity** Shows current average luminosity of the image.
- CurrentFrameCounterLow** Shows number of frames captured since the camera power up (lower 32 bits).
- CurrentFrameCounterHigh** Shows number of frames captured since the camera power up (upper 32-bits).

Exposure Auto PID Coefficients Category

▼ ExposureAutoPIDCoefficients	
ExposureAutoPMin	0.040000x
ExposureAutoPMax	8.000000x
ExposureAutoExposureForPMax	25000µs

- ExposureAutoPMin** Controls the minimum of the P coefficient for Exposure Auto control loop.
- ExposureAutoPMax** Controls the maximum of the P coefficient for Exposure Auto control loop.
- ExposureAutoExposureForPMax** Maps the maximum of the P coefficient to the value of exposure in the Exposure Auto control loop.

Gain Auto PID Coefficients Category

▼ GainAutoPIDCoefficients	
GainAutoPcoef	0.060000x
GainAutoIcoef	0.000000x
GainAutoDcoef	0.030000x

- GainAutoPcoef** Controls the P coefficient for Gain Auto control loop.
- GainAutoIcoef** Controls the I coefficient for Gain Auto control loop.
- GainAutoDcoef** Controls the D coefficient for Gain Auto control loop.

Data Correction Category

These parameters enable data correction and image improvements with Look-up tables and file corrections.

DataCorrection	
LUTEnable	Off
FFCEnable	Off
DefectPixelCorrection	Off
DefectPixelCorrectionMode	Average
BadPixelCorrection	Off
BadPixelCorrectionMode	Average
DefectPixelCountMax	1024
BadPixelCountMax	4096

LUTEnable	Selects LUT to be used in processing image (LUT1 – LUT4). LUT1 and LUT3 are pre-programmed with Gamma 0.45, LUT2 and LUT 4 are preprogrammed with negative LUT.
FFCEnable	Selects FFC to be used in processing image. FactoryFFC has a factory preset correction. You can create and load your FFC to FFC1–FFC7.
DefectPixelCorrection	Enables defect pixel correction. You can upload your own defect pixel map.
DefectPixelCorrectionMode	Controls the method used for replacing defective pixels.
BadPixelCorrection	Enables Hot Pixel Correction. You can upload your own hot pixel map.
BadPixelCorrectionMode	Controls the method used for replacing hot pixels.
DefectPixelCountMax	Maximum number of pixels in the Defect Pixel Correction Table.
BadPixelCountMax	Maximum number of pixels in the Hot Pixel Correction Table.

Digital IO Control Category

These controls enable you to map camera's inputs and outputs and configure strobes.

DigitalIOControl	
LineSelector	Input1
LineMode	Input
LineInverter	False
LineStatus	False
LineSource	Off
LineFormat	OptoCoupled
Strobe1Reference	Exposure
Strobe1Enable	On
Strobe1Width	1000
Strobe1Delay	10
Strobe2Reference	Exposure
Strobe2Enable	On
Strobe2Width	1000
Strobe2Delay	10

LineSelector Selects the physical line (or pin) of the external camera connector or the virtual line of the Transport Layer to configure.

LineMode Returns the status of the physical line used to input or output a signal.

LineInverter Controls the inversion of the signal of the selected input or output line.

LineStatus Returns the current signal level on the selected input or output line.

LineSource Maps the camera's internal signals to the respective Output. The signals are: ExposureStart, ExposureEnd, MidExposure, ExposureActive, TriggerActual, TriggerDelayed, PulseGenerator, Strobe1, Strobe2.

LineFormat Returns the current electrical format of the selected physical input or output line.

Strobe1Reference / Strobe2Reference Sets the reference event for the strobe signal.

Strobe1Enable / Strobe2Enable Enables or disables the strobe.

Strobe1Width / Strobe2Width Sets the strobe pulse duration in microseconds.

Strobe1Delay / Strobe2Delay Sets the strobe delay from the reference in microseconds.

Pulse Generator Category

The Pulse Generator provides a signal generator for camera sourced trigger or control signals.

▼ PulseGenerator	
PulseGenGranularity	x1uS
PulseGenWidth	1000
PulseGenPeriod	50000
PulseGenNumPulses	1
PulseGenMode	Continuous
PulseGenEnable	False

- PulseGenGranularity** Sets the Pulse Generator main timing resolution. The x1 resolution is in microseconds. The following four granularity steps are possible: x1, x10, x100, x1000 (x1000 is equal to 1 ms timing resolution).
- PulseGenWidth** Sets the value of the pulse width in microseconds.
- PulseGenPeriod** Sets the value of the pulse period in microseconds.
- PulseGenNumPulses** Sets the number of pulses generated by the Pulse Generator. To set Pulse Generator in continuous mode, set the parameter in 65536.
- PulseGenMode** Sets the mode of the Pulse Generator.
- PulseGenEnable** Enables the Pulse Generator.

Canon Lens Control Category

If using Canon EF Active lens mount, the following parameters are available for controlling the lens or checking its status. Please refer to the [Canon Lens Control](#) section for more information on lens adjusting procedures.

Controller Settings Category

▼ CanonLensControl	
▼ ControllerSettings	
InitLens	Execute
StopLens	Execute
LensControllerStatus	InitLens_Done
LensAF_MF	AutoFocus
GetLensID	Execute
LensID	9126

InitLens	Initializes the Canon Lens, if one is mounted to the camera. Always execute the <i>InitLens</i> command upon powering up.
StopLens	Removes the power from the Iris drive. Run <i>InitLens</i> command to resume the lens control.
LensControllerStatus	Shows status of Canon Lens initialization.
LensAF_MF	Shows status of Auto / manual focus switch located on the lens.
GetLensID	Request the value of the Lens ID register.
LensID	Returns the Lens ID after the <i>GetLensID</i> command is issued

Focus Category

▼ CanonLensControl	
> ControllerSettings	
▼ Focus	
NearFull	Execute
FarFull	Execute
FocusStepValue	1
NearStep	Execute
FarStep	Execute
FocusReqPosition	0
SetFocusPosition	Execute
FocusMax	0
FocusSetMax	Execute
FocusEncoderStatus	0
GetFocusEncoderStatus	Execute
ResetFocusEncoder	Execute

NearFull	Drives the focus to the fully Near position.
FarFull	Drives the focus to the fully Far position.
FocusStepValue	Sets the focus step size for <i>NearStep</i> and <i>FarStep</i> focus. A typical step size has a value of 4.
NearStep	Drives the focus toward the Near direction based on the amount defined in the <i>FocusStepValue</i> feature.
FarStep	Drives the focus toward the Far direction based on amount defined in the <i>FocusStepValue</i> feature.
FocusReqPosition	Sets the desired focus value to use with <i>SetFocusPosition</i> command.
SetFocusPosition	Drives the focus to the absolute position defined in the <i>FocusReqPosition</i> feature.
FocusMax	Returns maximum focus encoder limit.
FocusSetMax	Sets the maximum focus encoder limit by copying current encoder value
FocusEncoderStatus	Shows the current focus encoder value after issuing the <i>GetFocusEncoderStatus</i> command.
GetFocusEncoderStatus	Requests the focus encoder position value.
Reset Focus Encoder	Resets the Focus encoder.

Iris Category

▼ CanonLensControl	
> ControllerSettings	
> Focus	
▼ Iris	
IrisRequestedPositionRaw	0
SetIrisPosition	Execute
CurrentFNumber	4.55515
OpenIrisFull	Execute
CloseIrisStep	Execute
OpenIrisStep	Execute
IrisStepValue	1
GetIrisRange	Execute
IrisMin	43
IrisMax	80
IrisRange	502B2B2B

IrisRequestedPositionRaw	Sets raw iris absolute position.
SetIrisPosition	Drives the iris to the absolute position value of <i>IrisRequestedPositionRaw</i> .
CurrentFNumber	F-number value of the lens iris. Value of 0.0 signals an unknown iris position.
OpenIrisFull	Fully opens the iris.
CloseIrisStep	Closes the iris based on amount entered in the <i>IrisStepValue</i> feature.
OpenIrisStep	Opens the iris by the amount defined in the <i>IrisStepValue</i> feature.
IrisStepValue	Sets the iris step size (between 1 and 127) when using the <i>OpenIrisStep</i> and <i>CloseIrisStep</i> commands.
GetIrisRange	Determines the Iris Range. The values are read using the <i>GetIrisRange</i> command.
IrisMin	Returns the minimum iris limit.
IrisMax	Returns the maximum iris limit.
IrisRange	Shows the limit values of the iris after issuing the <i>GetIrisRange</i> command.

Transport Layer Control Category

The Transport Layer controls the exchange of data between the camera and the host computer.

▼ TransportLayerControl	
PayloadSize	31415040
▼ GigEvision	
GevMACAddress	08:ED:02:10:03:1A
GevCurrentIPConfigurationLLA	False
GevCurrentIPConfigurationDHCP	False
GevCurrentIPConfigurationPersistentIP	False
GevCurrentIPAddress	169.254.145.188
GevCurrentSubnetMask	255.255.0.0
GevCurrentDefaultGateway	0.0.0.0
GevPersistentIPAddress	0.0.0.0
GevPersistentSubnetMask	0.0.0.0
GevPersistentDefaultGateway	0.0.0.0
GevLinkSpeed	0
GevFirstURL	LOCAL:lpX10G_CheetahPregius_1.1.2.zip;31...
GevSecondURL	
GevCCP	ExclusiveAccess
GevPrimaryApplicationSocket	43257
GevPrimaryApplicationIPAddress	169.254.96.87
GevMCPHostPort	63913
GevMCDA	169.254.96.87
GevMCTT	400
GevMCRC	3
GevMCSP	49152
GevSCCFGUnconditionalStreaming	False
GevSCPHostPort	0
GevSCPSFireTestPacket	False
GevSCPSDoNotFragment	True
GevSCPD	128
GevSCDA	0.0.0.0
GevSCPSPacketSize	8164
GevHeartbeatTimeout	5000
GevTimestampTickFrequency	132000000
GevTimestampControlLatch	Execute
GevTimestampControlReset	Execute
GevTimestampValue	797491

PayloadSize Provides the number of bytes transferred for each image on the stream channel, including any end-of-line, end-of-frame statistics, or other stamp data.

GevMACAddress Displays the MAC address of the Ethernet network interface.

GevCurrentIPConfigurationLLA Indicates whether a Link Local Address IP configuration scheme is activated on the network interface.

GevCurrentIPConfigurationDHCP	Indicates whether a DHCP IP configuration scheme is activated on the network interface.
GevCurrentIPConfigurationPersistentIP	Indicates whether a Persistent IP configuration scheme is activated on the network interface. A persistent IP address is hard-coded in non-volatile memory.
GevCurrentIPAddress	Displays the host computer's network IP Address.
GevCurrentSubnetMask	Displays the subnet mask of the interface.
GevCurrentDefaultGateway	Displays the default gateway IP address to be used on the network interface.
GevPersistentIPAddress	Indicates the Persistent IP address for the network interface. The persistent IP address is re-used by the camera on power-up when Persistent IP is enabled.
GevPersistentSubnetMask	Indicates the Persistent subnet mask associated with the Persistent IP address on the network interface.
GevPersistentDefaultGateway	Indicates the Persistent default gateway for the network interface.
GevLinkSpeed	Indicates the speed of transmission negotiated by network interface in Mbps.
GevCCP	Enables granting privilege to an application. Options are open access, exclusive access, or control access.
GevPrimary Application Socket	Indicates the UDP source port of the primary application.
GevPrimary Application IP Address	Indicates the address of the primary application.
GevMCPHostPort	Controls the port to which the device must send messages. Setting this value to 0 closes the message channel.
GevMCDA	Controls the destination IP address for the message channel.
GevMCTT	Provides the message channel transmission timeout value in milliseconds.
GevMCRC	Controls the number of retransmissions allowed when a message channel message times out.
GevMCSP	Indicates the source port for the message channel.
GevSCCFG UnconditionalStreaming	Enables the camera to continue to stream for this stream channel if its control channel is closed or regardless of the reception of any ICMP messages (such as destination unreachable messages).
GevSCPHostPort	Indicates the port to which the device must send data stream.
GevSCPSFireTestPacket	When this bit is set, the device will fire one test packet.
GevSCPSDoNotFragment	This bit is copied into the "do not fragment" bit of IP header of each stream packet.
GevSCPD	Indicates the delay (in timestamp counter unit) to insert between each packet for this stream channel.
GevSCDA	Indicates the destination IP address for this stream channel.

- GevSCSPacketSize** The stream packet size to send on this channel, except for data leader and data trailer, and the last data packet that might be of smaller size (since packet size is not necessarily a multiple of block size for stream channel).
- GevHeartbeatTimeout** Indicates the current heartbeat timeout in milliseconds.
- GevTimestampTickFrequency** This 64-bit feature indicates the number of timestamp ticks during 1 second.
- GevTimestampControlLatch** Latches current timestamp counter into "Timestamp value" register.
- GevTimestampControlReset** Resets timestamp 64-bit counter to 0.
- GevTimestampValue** Reports the latched 64-bit value of the timestamp counter

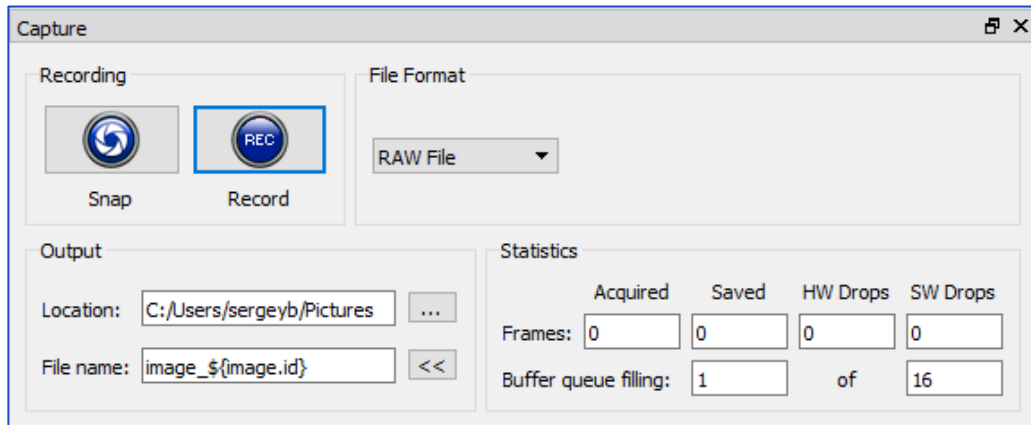
User Set Control Category

▼ UserSetControl	
UserSetSelector	Default
UserSetLoad	Execute
UserSetSave	<Value not available>
UserSetDefault	Default

- UserSetSelector** Points to User Configuration Set (Default, User Set 0...User Set 3) to load into the camera or save into the camera’s non-volatile memory. Default is the Factory Default Settings.
- UserSetLoad** Loads the User Set specified by UserSetSelector into the camera workspace (volatile).
- UserSetSave** Saves the User Configuration Set 0, 1, 2, or 3 specified by UserSetSelector to the camera’s non-volatile memory. The Default User Set is read only and cannot be modified by the user.
- UserSetDefault** Points to User Configuration Set, which will be loaded and made active when the device is reset or after power is applied.

Capture Panel

The Capture panel provides options for recording images and video and saving them to the computer hard drive. Click the Capture tab at the bottom of the IpxPlayer screen to access the panel.



Recording Acquired Images

Use the Recording section of the Capture screen to record snapped images or video images. The screen displays real-time capture information during recording.

- Snap** Saves the current image to the hard drive.
- Record** Starts or stops saving video to the hard drive.
- Statistics** Shows the number of frames acquired, saved, and dropped during the current capture session. Dropped frames are frames received from the camera but not transferred due to a lack of host buffers.
- Buffer Queue Filling** Shows the current filling status of the capture frames queue.

Saving Image Output

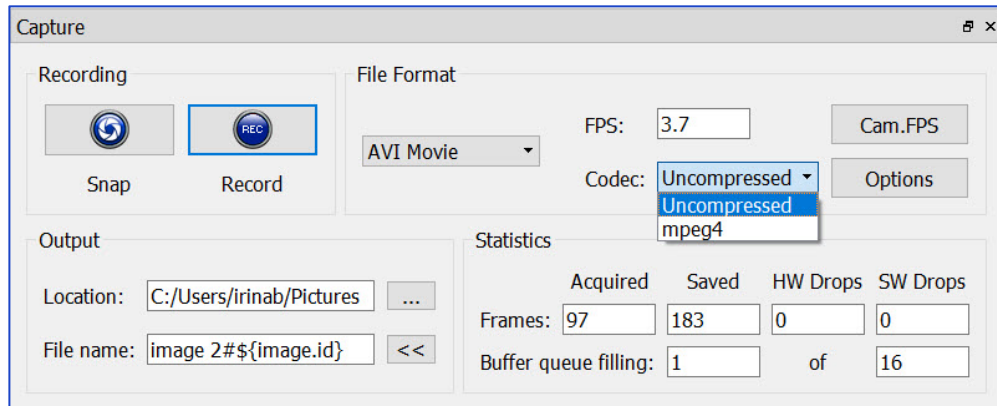
The Output section of the Capture screen lets you configure the location and format of saved images in the computer.

- Output Location** You determine where to save files on the computer.
- File Name** Defines the file name template.
- File Format** Allows you to specify the output file format from a drop-down list.
 - RAW File. This is an unprocessed file format.
 - BMP Image. (8-bpp BMP for grayscale, 24-bpp for Color images)
 - JPG Image. You can adjust the image quality. Default is 85%.
 - TIFF Image. Normalized option affects pixel intensity values.
 - AVI Movie. Options are – you can set the frames per second or get the current frames per second from the camera (see the [Saving Image in AVI Movie File Format](#) section).

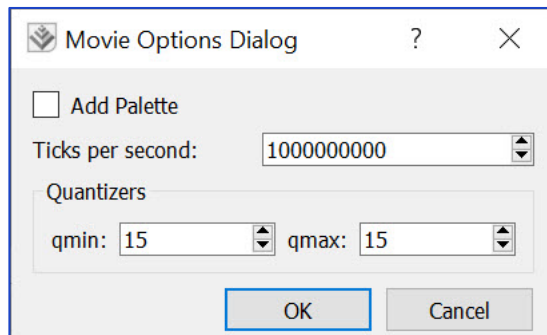
Saving Image in AVI Movie File Format

When saving images in AVI Movie format, follow the steps below:

1. In the **File Format** drop-down list, select AVI Movie.
2. In the **Codec** drop-down list, select a compression method—MPEG 4 or Uncompressed.
3. In the **FPS** field, enter a desired value of the frame rate or click **Cam.FPS** to get the current frames per second from the camera.



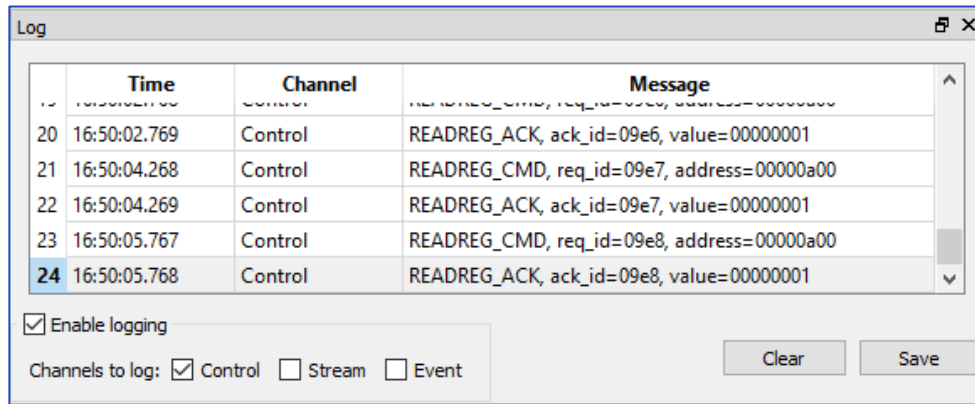
4. Click **Options**.
The Movie Options Dialog screen appears.
5. If pixel format of the images is 8-bit per pixel and the AVI file is to be viewed in Windows OS, check the **Add Palette** checkbox to add a palette to 8-bit bitmap image.



6. Make sure that a value of the **Ticks per second** parameter matches the value of the *GevTimestampTickFrequency* parameter.
7. Set minimum and maximum quantizers and click **OK**.

Log Panel

The Log panel shows data transfers to or from the connected camera. Log information provides a numeric identifier assigned by the application, the transfer time, the control channel, and the message. Click the Log tab at the bottom of the IpxPlayer screen to access the panel.



Channels to Log

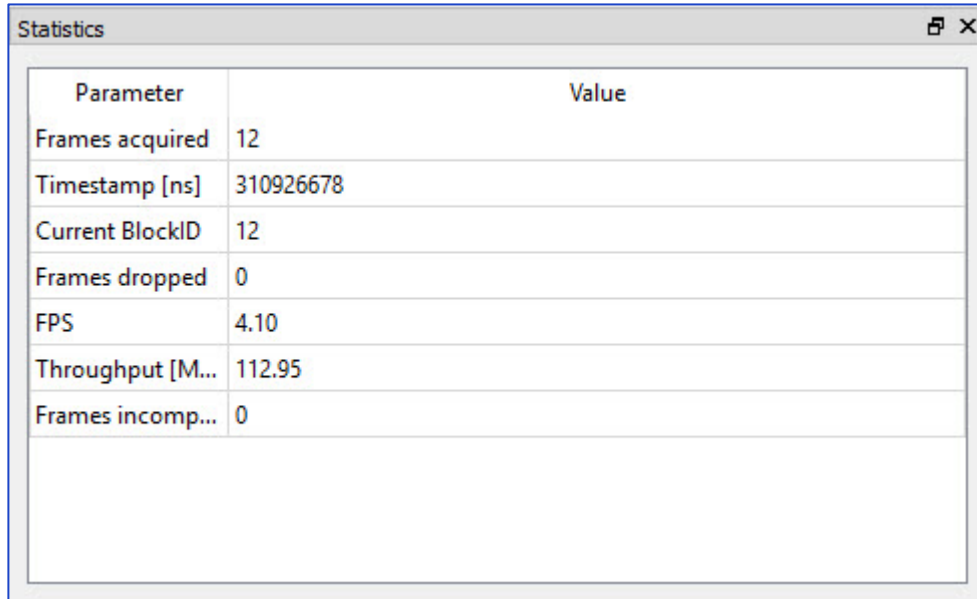
The Enable Logging check box initiates logging. You can save current log data to a TXT file (.txt) with space-separated fields.

You must select a channel to log. Channels are device channels linked to an appropriate camera interface. The following options are available:

- Control Channel** This is a data interface linked to the camera's Device Control Channel. The Control Channel is dedicated to camera parameters control. It sends and receives the data displayed on the Camera Parameters panel. The Control Channel is bi-directional, enabling data transfers from the host computer to the camera or from the camera to the host computer.
- Stream Channel** This links to the camera's Device Stream Channel. The Stream Channel is dedicated to transferring video data from the camera to the host computer.
- Event Channel** This links to the camera's Device Event Channel. The Event Channel notifies the host computer software about any events on the camera side. For example, the camera can notify the software that it received the trigger signal.

Statistics Panel

The Statistics panel displays camera performance and other information based on settings and parameters.

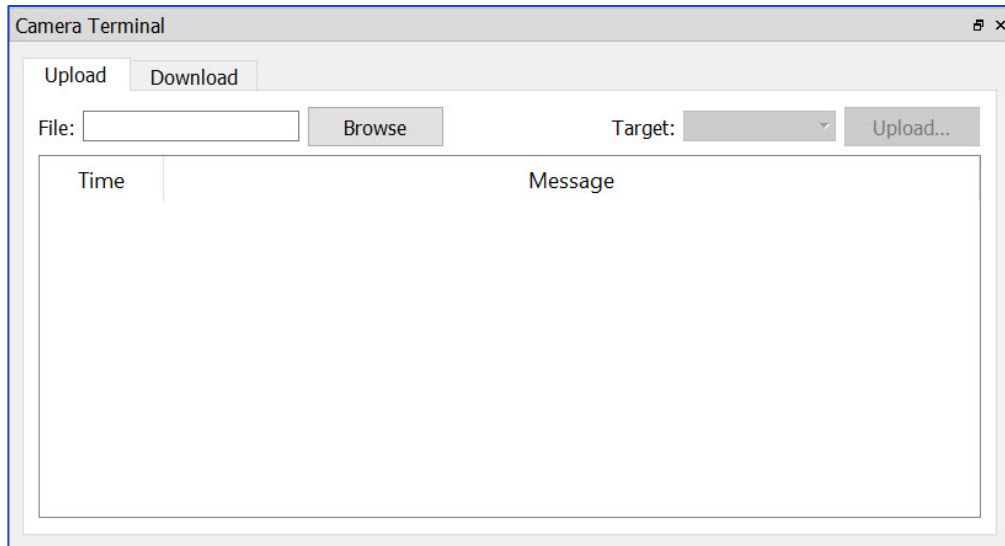


Parameter	Value
Frames acquired	12
Timestamp [ns]	310926678
Current BlockID	12
Frames dropped	0
FPS	4.10
Throughput [M...	112.95
Frames incomp...	0

Frames acquired	The number of frames acquired after you click the Play button.
Timestamp [ns]	The current value of the timestamp in the acquired image in nanoseconds.
Current Block ID	The current value of the block ID in the acquired image.
Frames dropped	The number of frames dropped by the camera (calculated from consequence block IDs).
FPS	The number of frames per second.
Throughput [MB/s]	The average throughput value of the camera interface in megabytes per second.

Camera Terminal Panel

The Camera Terminal panel lets you upload and download any custom files—DPM, HPM, Flat Field Correction (FFC), or Lookup Tables (LUT). It also allows you to upload Firmware updates.



Uploading Files

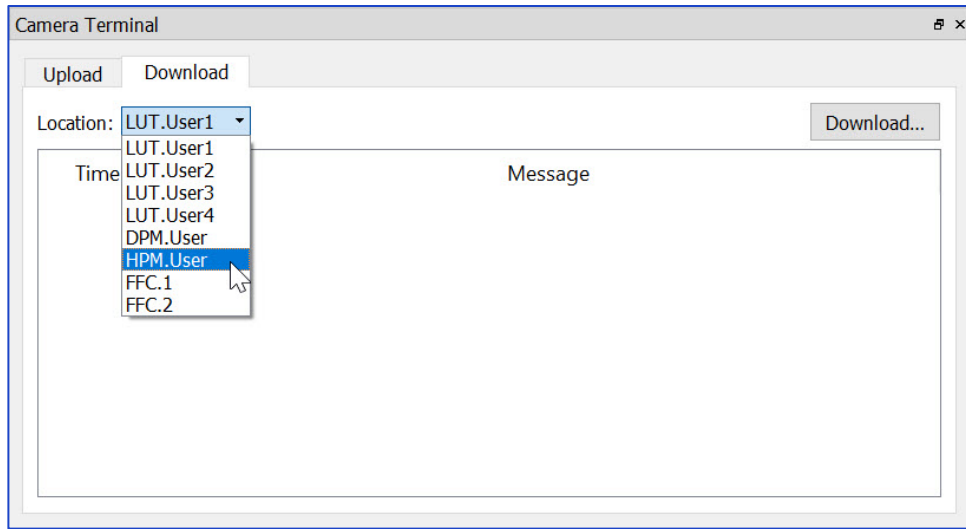
To upload DPM, HPM, FFC, or LUT files from the camera, follow the steps below.

1. On the Upload tab, click **Browse** and navigate to a file (ZIP, RGS, DPM, HPM, FFC, or LUT).
2. Select the file you want to upload.
3. Select a **Target** location for the file.
4. Click **Upload...**
Reboot the camera and restart the IpxPlayer for the changes to take into effect.

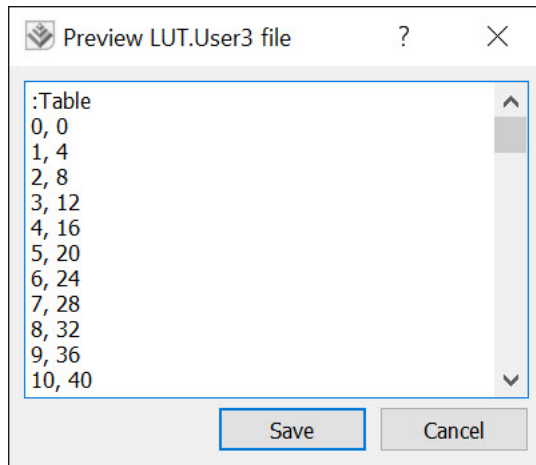
Downloading Files

To download DPM, HPM, FFC, or LUT files into the camera, follow the steps below.

1. On the Download tab, select a **Location** from which to download a file.

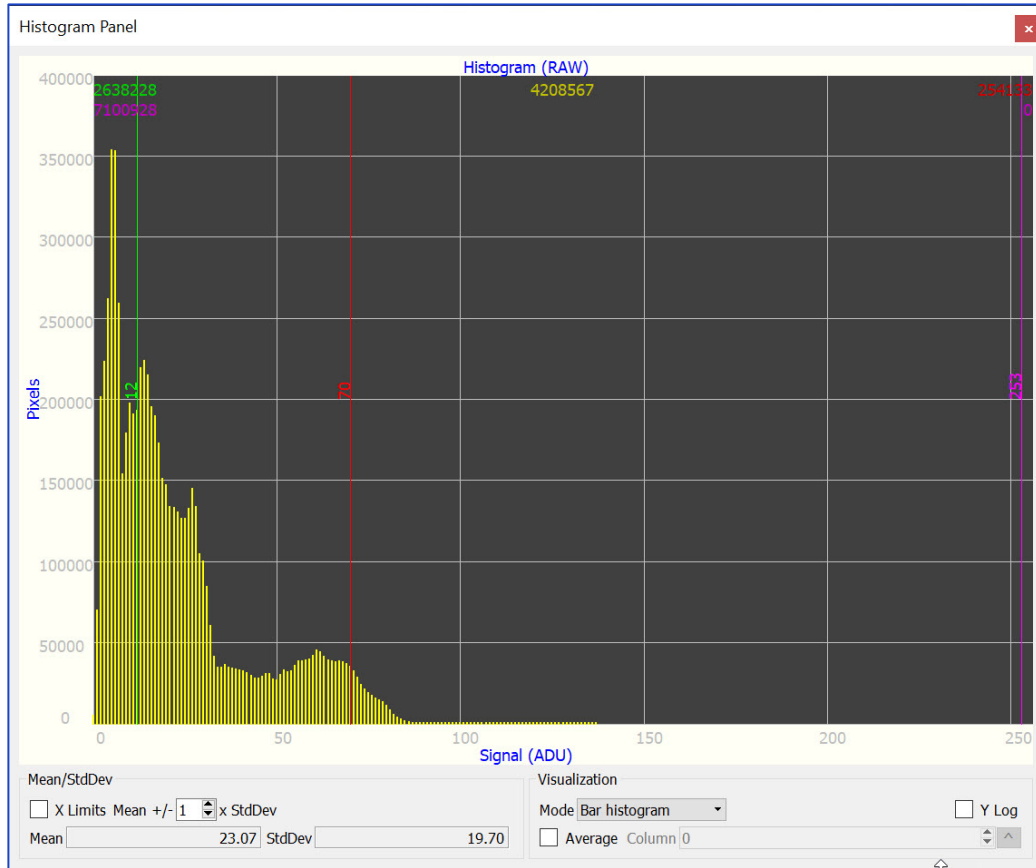


2. Click **Download...**
A readout begins.
3. Upon completing the readout, click **Save**.



Histogram Panel

The Histogram panel shows pixel values in ADU.



Mean/StdDev Pane

- X Limits**

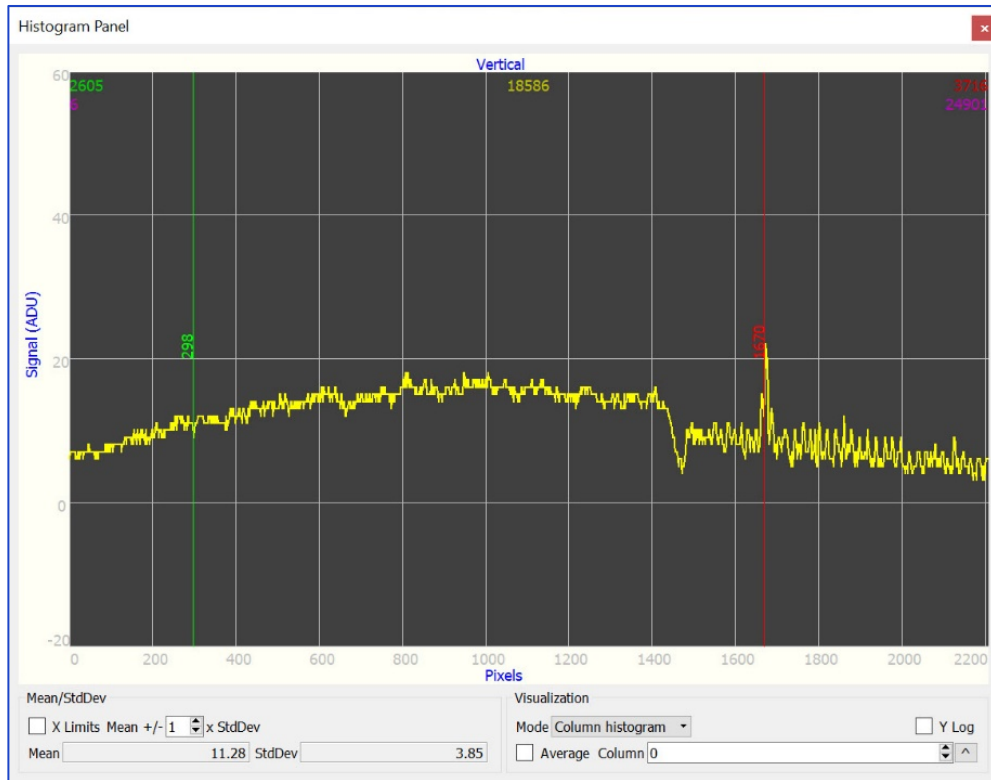
Enables/disables X axis scale adjustments.
 By default, the pixel values are shown within 0–255 ADU. To change the limits, check the X Limits check box and select a coefficient (1–10). The new X axis limits are:

Max. limit = Mean + StdDev x coefficient.
 Min. limit = Mean – StdDev x coefficient.
- Mean**

Shows the mean pixel value (in ADU)
- StdDev**

Shows the standard deviation of pixel values (in ADU)

- Column histogram** Shows pixels' values in ADU in the selected column.



Row/Column selects a row/column coordinate to use in calculation.

Set the visualization **Mode** to **Row histogram** or **Column histogram** and select a row/column coordinate.

Average when checked, shows average pixels' values in the selected row/column.

Y Log when checked, a logarithmic Y axis is enabled.

Hex Pixel Dump Panel

The Hex Pixel Dump panel shows pixel values in the table in hex format. The active area is highlighted with a yellow frame on the display.

image column numbers

	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285
1788	R 3c G 44 B 11	R 3e G 47 B 12	R 40 G 4b B 12	R 42 G 4e B 13	R 43 G 50 B 14	R 44 G 54 B 16	R 46 G 55 B 18	R 47 G 57 B 19	R 48 G 58 B 19	R 48 G 5a B 1a	R 4a G 5f B 1a	R 4c G 62 B 1b	R 4c G 61 B 1c	R 4d G 61 B 1c
1789	R 3c G 42 B 11	R 3d G 46 B 11	R 40 G 4b B 12	R 42 G 4d B 13	R 44 G 4f B 15	R 45 G 53 B 16	R 46 G 56 B 17	R 47 G 55 B 18	R 48 G 56 B 19	R 48 G 5a B 1a	R 4a G 5f B 1b	R 4b G 61 B 1b	R 4c G 62 B 1b	R 4d G 63 B 1b
1790	R 3c G 43 B 10	R 3e G 45 B 11	R 40 G 4a B 12	R 42 G 4c B 14	R 44 G 4f B 15	R 44 G 53 B 16	R 45 G 55 B 16	R 46 G 56 B 17	R 47 G 57 B 18	R 48 G 58 B 1a	R 4a G 5e B 1b	R 4c G 61 B 1b	R 4c G 63 B 1a	R 4c G 66 B 1b
1791	R 3d G 44 B 10	R 3e G 46 B 11	R 41 G 4a B 12	R 44 G 4d B 14	R 44 G 4e B 15	R 43 G 52 B 16	R 44 G 54 B 17	R 45 G 57 B 17	R 47 G 59 B 18	R 48 G 5b B 19	R 4a G 5f B 1a	R 4c G 61 B 1b	R 4c G 62 B 1b	R 4b G 63 B 1b
1792	R 3d G 44 B 10	R 3e G 46 B 11	R 40 G 4a B 12	R 43 G 4e B 14	R 43 G 4f B 15	R 44 G 51 B 16	R 45 G 54 B 17	R 46 G 57 B 17	R 47 G 57 B 17	R 49 G 5d B 18	R 4a G 5e B 19	R 4c G 60 B 1b	R 4c G 62 B 1c	R 4c G 61 B 1c
1793	R 3c G 44 B 10	R 3e G 47 B 11	R 40 G 4a B 12	R 41 G 4e B 13	R 43 G 50 B 15	R 45 G 52 B 16	R 46 G 53 B 17	R 47 G 56 B 17	R 48 G 59 B 18	R 49 G 5c B 19	R 4a G 5d B 1a	R 4b G 60 B 1b	R 4c G 63 B 1c	R 4c G 62 B 1b
1794	R 3b G 45 B 0f	R 3d G 47 B 10	R 3f G 4b B 11	R 41 G 4e B 13	R 43 G 51 B 14	R 45 G 54 B 16	R 46 G 54 B 17	R 47 G 55 B 18	R 48 G 59 B 18	R 49 G 5b B 1a	R 4a G 5d B 1b	R 4c G 60 B 1b	R 4c G 62 B 1b	R 4c G 62 B 1b
1795	R 3b G 45 B 10	R 3c G 48 B 11	R 3e G 4c B 12	R 40 G 4e B 13	R 42 G 50 B 14	R 44 G 53 B 15	R 46 G 55 B 16	R 47 G 56 B 17	R 48 G 5a B 18	R 49 G 5b B 19	R 4b G 5c B 1b	R 4c G 60 B 1b	R 4c G 61 B 1b	R 4c G 62 B 1b
	R 3c G 45 B 10	R 3e G 48 B 11	R 3f G 4c B 12	R 40 G 4e B 13	R 41 G 50 B 14	R 43 G 53 B 15	R 45 G 55 B 16	R 46 G 56 B 17	R 48 G 5a B 18	R 4a G 5b B 19	R 4a G 5c B 1b	R 4b G 60 B 1b	R 4b G 61 B 1b	R 4b G 62 B 1b

image row numbers

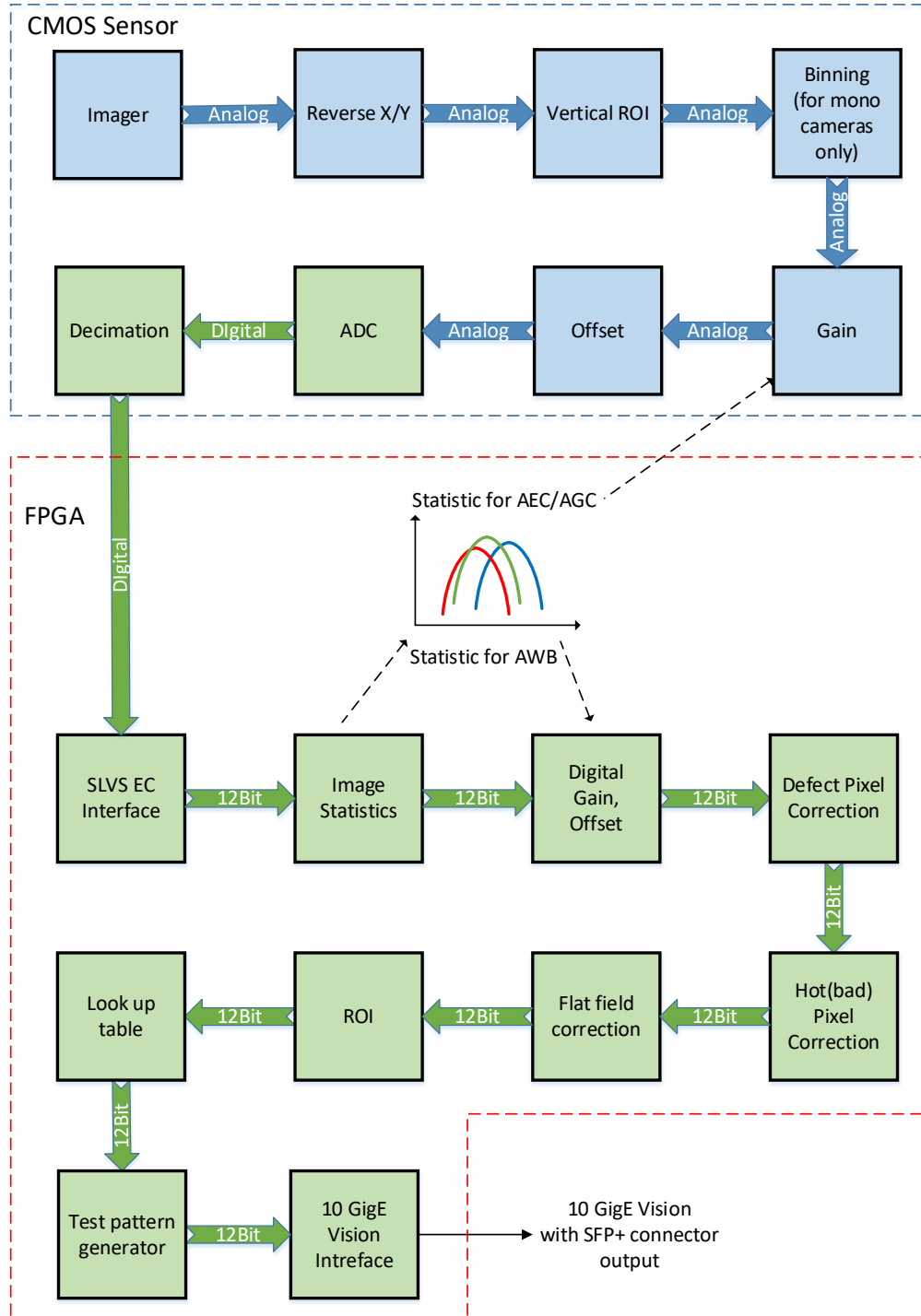
The pixel value is shown in RGB values for color images, and in Y (luminosity) values for monochrome image.

For the Hex pixel Dump to display the pixel values correctly, set the **Hex Pixel Dump data** parameter in the menu *File > Settings* with respect to the pixel format as shown below.

	Pixel Format	
	Packed	Unpacked
Hex Pixel Dump data	Processed	Either RAW or Processed

Camera Features

Image Data Flow



Exposure Control

The camera provides three exposure control modes—**Off**, **Timed**, and **Trigger Width**.

In the **Timed** mode, you can control exposure time manually or automatically. To enable manual control, set *ExposureAuto* to Off and specify the exposure time using the *ExposureTime* setting.

To enable AEC (Automatic Exposure Control), set *ExposureAuto* to Once or Continuous. Please refer to the section [Automatic Exposure and Gain Control](#) for more information on AEC.

The camera works either in trigger (Standard or Fast Trigger) or free-running (untriggered) mode, you might need to also adjust trigger parameters when setting exposure (refer to the section [Camera Triggering](#) for more information on trigger parameters).

NOTE (★) The AEC is not available when exposure mode is set to **Trigger Width**.

Exposure Control in Free-Running Mode

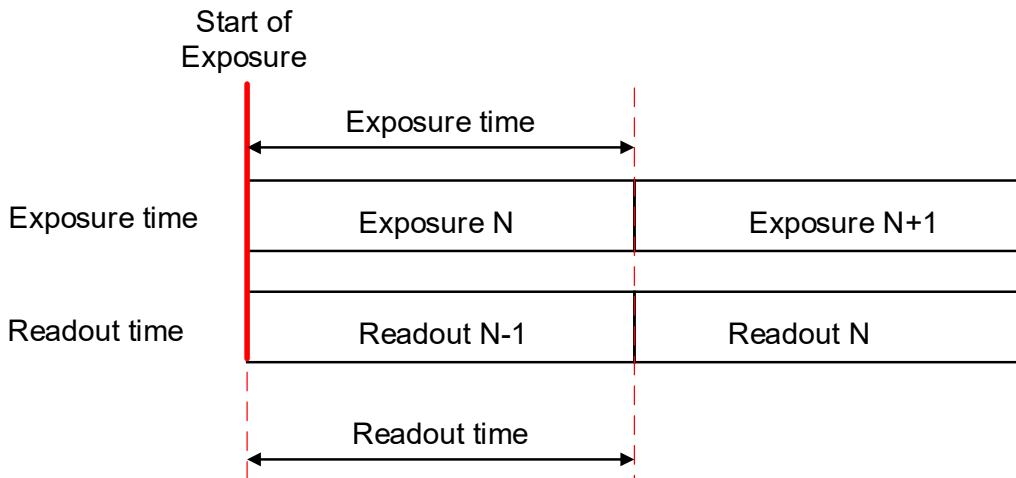
In **free-running mode**, the camera constantly reads out the sensor, and the exposure time is determined by the frame readout time. The exposure time equals the frame read out time when the exposure mode is set to **Off**.

Free-running mode, Exposure control is Off

Settings:

Exposure Mode: **Off**

Trigger Mode: **Off**



To reduce the image exposure time under bright lighting conditions, set the exposure control mode to **Timed**. The electronic exposure control does not affect the frame rate; it only changes the exposure time. When the Timed mode is active, the camera controls the start of exposure, so the new exposure ends just as the readout of the current frame ends and the readout of the next frame begins.

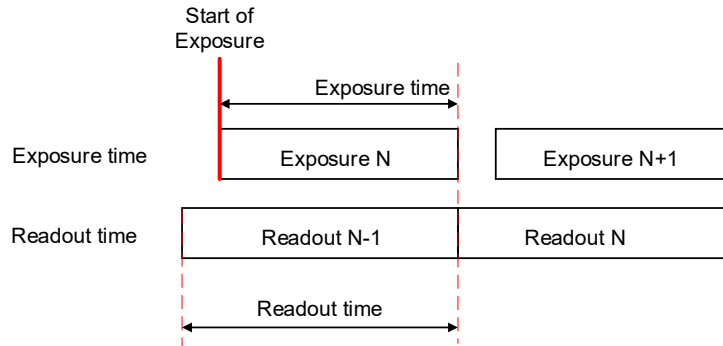
Free-running mode, Exposure control is Timed

Settings:

Exposure Mode: **Timed**

Trigger Mode: **Off**

Exposure Time: **User-specified** (Min. = 36 μ s; Max = Readout time)



To configure the camera to work in free-running mode with Timed exposure control:

1. Turn off the camera image acquisition.
2. Set *ExposureAuto* to **Off** for manual exposure control, or to either **Once** or **Continuous** for automatic exposure control.
3. In the Acquisition Control menu:
 - Set *TriggerMode* to **Off**.
 - Set *ExposureMode* to **Timed**.
 - If *ExposureAuto* is **Off**, then set *ExposureTime* (in microseconds) to a user-specified value.

NOTE *

In free-running mode, the maximum exposure time equals frame time. You can extend the exposure time by increasing the frame time:

1. Check *AcquisitionFrameRateEnable* box.
2. Increase the frame time by using *AcquisitionFrameTime* (in μ s) or *AcquisitionFrameRate* (in Hz) settings.
3. Set *ExposureTime* within the extended frame time range.

In free-running mode, the minimum exposure is 36 μ s.

While the *ExposureTime* allows for 1- μ s increments, the *CurrentExposureTime* increment equals 1-line time in μ s.

Exposure Control in Trigger Mode

In **trigger mode**, you can synchronize the camera's acquisition cycle to an external signal by setting the exposure control to either Timed or Trigger Width. Trigger mode can be set to either Standard or Fast (see [Camera Triggering](#)).

NOTE ⚠ The electronic exposure control does not affect the camera's frame rate in Fast trigger mode, because the exposure and readout operations are overlapped in time. In Standard Trigger mode, the maximum frame rate depends upon the exposure time, because the exposure and readout occur sequentially (not overlapped).

In **Timed** exposure control mode, you can set the external trigger pulse to control the start of exposure.

1. Turn off the camera image acquisition.
2. Set *ExposureAuto* to **Off** for manual exposure control, or to either **Once** or **Continuous** for automatic exposure control.
3. In the Acquisition Control menu:
 - Set *TriggerMode* to **On**.
 - Set *ExposureMode* to **Timed**.
 - If *ExposureAuto* is **Off**, then set *ExposureTime* (in μs) to a user-specified value.

NOTE ⚠ While the *ExposureTime* allows for 1- μs increments, the *CurrentExposureTime* increment equals 1-line time in μs .

4. Configure the trigger parameters.
Please refer to the section [Configuring the Trigger](#), steps 3–6.

In **Trigger Width** mode, you can set the external trigger signal to control the start and duration of exposure. This mode is available in both Standard and Fast trigger modes (refer to the section [Trigger Modes](#)).

To configure the camera to work in **Trigger Width** Exposure mode:

1. Turn off the camera image acquisition.
2. Make sure that *ExposureAuto* is **Off** and *AcquisitionFrameRateEnable* is False.
3. In the Acquisition Control menu:
 - Set *TriggerMode* to **On**.
 - Set *ExposureMode* to **TriggerWidth**.
4. Configure the trigger pulse parameters.
Please refer to the section [Configuring the Trigger](#), steps 3–6.

NOTE ⚠ In Standard Trigger mode, the maximum exposure time is defined by the formula:

$$\text{Exposure Time (max)} = \text{Trigger Period} - \text{Readout Time},$$

where the Readout Time is equal to the *CurrentFrameTime* (in free-running mode, with *AcquisitionFrameRateEnable* off).

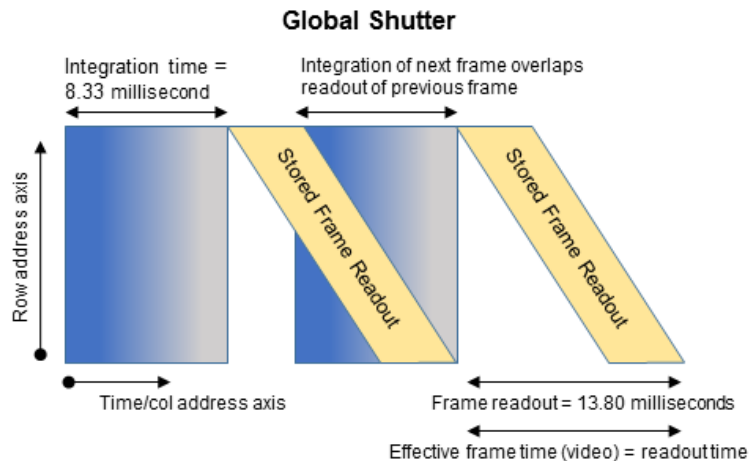
In Standard trigger mode, the minimum exposure is equal to 1 line time. This value depends on a sensor model and some other parameters such as *PixelFormat*.

In Fast Trigger mode, the maximum exposure time is 16 s.

Global Shutter

In global shutter mode, all pixels in the array reset at the same time, then collect signal during the exposure time, and finally transfer the image to a pixel memory region within each pixel. After transferring the image to the pixel memory region, the readout of the array begins. In this way, all pixels capture the image during the same period, which reduces any image artifacts due to motion within the scene. The maximum exposure is frame-time dependent, and the minimum exposure varies based on the image sensor.

The camera overlaps the exposure and read-out times in free-running and Fast Trigger modes as shown in the following figure.



Automatic Exposure and Gain Control

Automatic exposure control (AEC) and automatic gain control (AGC) enable the camera to maintain the same image brightness during the changing lighting conditions. You can enable both AEC and AGC independently or together by setting *ExposureAuto* and *GainAuto* to either **Once** or **Continuous**.

AEC/AGC Mode	Description
Off	AEC/AGC is disabled and a manual control is on. The camera applies the exposure time and gain you enter using the <i>ExposureTime</i> and <i>Gain</i> controls.
Once	Exposure duration/gain is adapted once by the camera. Once it has converged, it returns to the Off state; and the exposure and gains determined during the Once process are maintained until changed manually.
Continuous	Exposure duration/gain is constantly adapted by the camera to maximize the dynamic range.

When AEC / AGC are in **Continuous** or **Once** mode, you can set the image luminance (brightness) target (*ExposureGainAutoTarget*), and the camera adjusts the exposure and/or gain accordingly. The luminance target is a 12-bit value (4095 is a max. value). To determine the luminance target when using 8-bits per pixel, take the desired output in ADUs and multiply this value by 16. The target luminance is the average luminance within the image.

Also, for the **Once** mode, you can set an acceptable difference between the target and current image luminance (*ExposureGainAutoTargetThreshold*) in the range from 0 to 4095. When the threshold is reached, the camera turns off AEC/AGC algorithms and enables manual control over exposure duration and/or gain.



In some rapidly changing and bright light conditions, an image brightness oscillation (image intensity flipping from bright to dark) could occur. To prevent this, increase the AEC minimum exposure setting, increase the target luminance level and/or decrease the lens iris.

Initial conditions for AEC and AGC algorithms:

Exposure and gain are set to the user-specified values of the *ExposureTime* and *Gain* controls.

When AEC and AGC are enabled together, you might need to select whether to adjust gain or exposure first using *ExposureGainAutoPriority* control.

- If the **exposure priority** is selected (**ExposureTime**), the camera adjusts the exposure first within the user-specified minimum/maximum limits. If one of the limits is reached before the target image luminance (or threshold) is achieved, then gain is applied. The camera varies the gain until either the target image luminance (or threshold) is reached or one of gain limits is reached.
- If the **gain priority** is selected (**Gain**), the camera adjusts the gain first within the user-specified minimum/maximum limits. If one of the limits is reached before the target image

luminance (or threshold) is achieved, the exposure is applied. The camera varies the exposure until either the target image luminance (or threshold) is reached or one of exposure limits is reached.

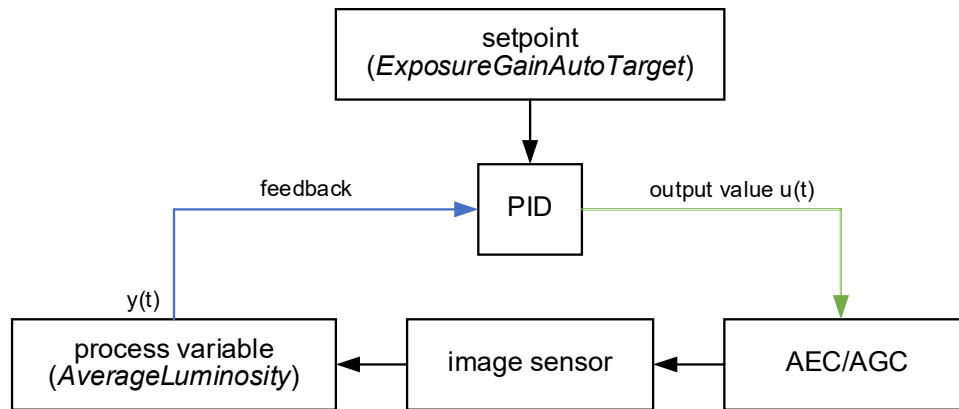
By default, the *ExposureGainAutoPriority* control are set to **ExposureTime**.

The AEC and AGC algorithms sample all pixels for the entire frame. The camera displays the current luminance within the frame.

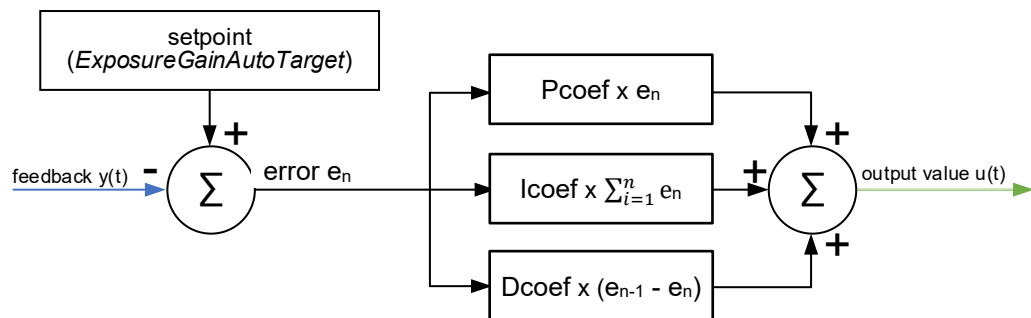
P, I, and D Coefficients

The P (Proportional), I (Integral), and D (Derivative) coefficients of PID feed-back control loops determine speed and stability of AEC and AGC algorithms.

A PID controller continuously calculates a difference (an error) between a setpoint (SP)—*ExposureGainAutoTarget*— and a process variable (PV)—*AverageLuminosity*. Based on the sum of proportional, integral, and derivative responses, the controller determines an output value and adjusts exposure or gain to minimize the error. The PID controller continuously varies the output value until the luminance reaches the setpoint.



The AGC algorithm uses all three responses with a manual control available over the P, I, and D coefficients.



The AEC algorithm uses only two responses – proportional and derivative with a manual control available over the P coefficient only.

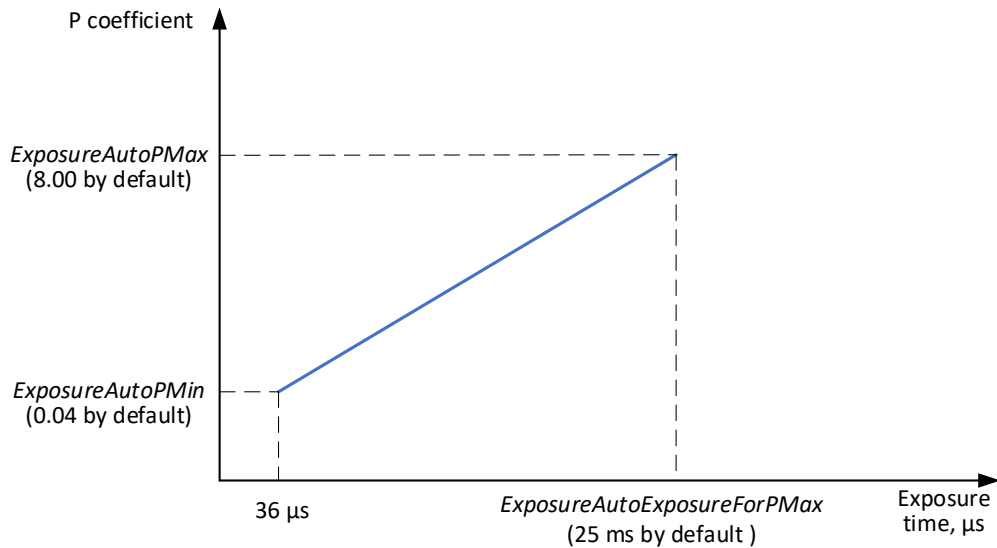
AEC/AGC	PID coefficients controls
AEC	P varies depending on exposure I = 0 D = P/2
AGC	P, I, and D are fixed values

Proportional Response

The proportional response is a difference (error) between the setpoint and the process variable. This error is then multiplied by the proportional coefficient P.

NOTE ⚠ Increasing the P coefficient increases the speed of the control algorithm and degrades its stability. If the P coefficient is too high, the image luminance begins to oscillate. With further increase of the P coefficient, the oscillations become larger, and the system becomes unstable and may even oscillate out of control.

The AEC algorithm uses an adaptive P coefficient.



The PID controller applies the P coefficient calculated on the previous iteration, computes the error, and adjusts exposure. The controller then re-calculates the P coefficient and applies the new value in the next iteration.

Integral Response

The integral response is the sum of the calculated errors over time multiplied by the integral coefficient I.

NOTE ⚠ Increasing the I coefficient decreases the speed of the control algorithm and degrades its stability.

Derivative response

The derivative response is the difference between the error found on the previous sample and the current error multiplied by the derivative coefficient D. The derivative response is sensitive to noise in the process variable signal. use very small derivative time

NOTE ⚠ Increasing the D coefficient increases the speed of the control algorithm and improves its stability.


CAUTION

We do not recommend changing P, I, and D coefficients. Changing the coefficients may cause oscillations and destabilize the system.

If you need to change the coefficients, please contact Imperx support.

Imperx sets up optimal P, I, and D coefficients to balance the speed and stability of AEC and AGC algorithms.

XML Parameter	Default value
For AEC algorithm:	
ExposureAutoPMin	0.04
ExposureAutoPMax	8.00
ExposureAutoExposureForPMax	25,000 microseconds
For AGC algorithm:	
GainAutoPcoef	0.06
GainAutoIcoef	0.00
GainAutoDcoef	0.03

Camera Triggering

Use the **Trigger mode** control to synchronize the camera to an external event and acquire an image at a specific time. A trigger pulse is issued when the external event occurs. The camera then receives the trigger and acquires the images.

You can set the number of frames to acquire for each trigger using *AcquisitionBurstFrameCount* control. By default, *AcquisitionBurstFrameCount* is equal to 1 frame. The maximum number of frames is 65535.

Trigger Modes

The camera supports Standard and Fast Trigger modes. For the camera to work in the Standard Trigger mode, set *TriggerOverlap* parameter to Off. For the camera to work in the Fast Trigger mode, set *TriggerOverlap* parameter to ReadOut.

Standard Trigger Mode

In **Standard Trigger mode**, the camera first performs the exposure and then reads out the image. An external timing pulse controls the start of the exposure if exposure control mode is set to **Timed**.

Standard trigger mode, Exposure control is Timed

GenICam controls

TriggerMode: **On**

TriggerOverlap: **Off**

TriggerSource: **Line 1** (or Line2, Software, Pulse Generator)

TriggerActivation: **Rising Edge** (or Falling Edge)

TriggerFilterTime, TriggerDelay, TriggerDebounceTime: – **set if applicable**.

Exposure Mode: **Timed**

For manual exposure control:

Exposure Time: **User-specified** (Min.= 36 μ s; Max = Readout time)

ExposureAuto: **Off**

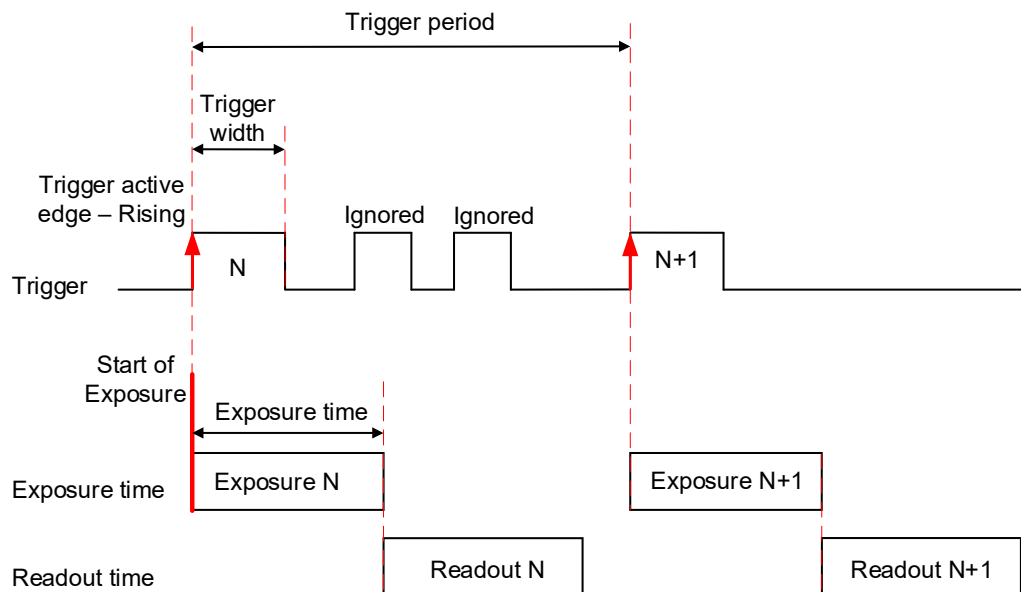
For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

Parameters of the external trigger pulse

Trigger width: $\geq 10 \mu$ s

Trigger period (min) = Exposure time (max) + Readout time



Setting exposure control mode to **Trigger Width** allows the external timing pulse to control the exposure duration.

Standard trigger mode, Exposure control is Trigger Width

GenICam controls

TriggerMode: **On**

TriggerOverlap: **Off**

TriggerSource: **Line 1** (or Line2, Pulse Generator)

TriggerActivation: **Rising Edge** (or Falling Edge)

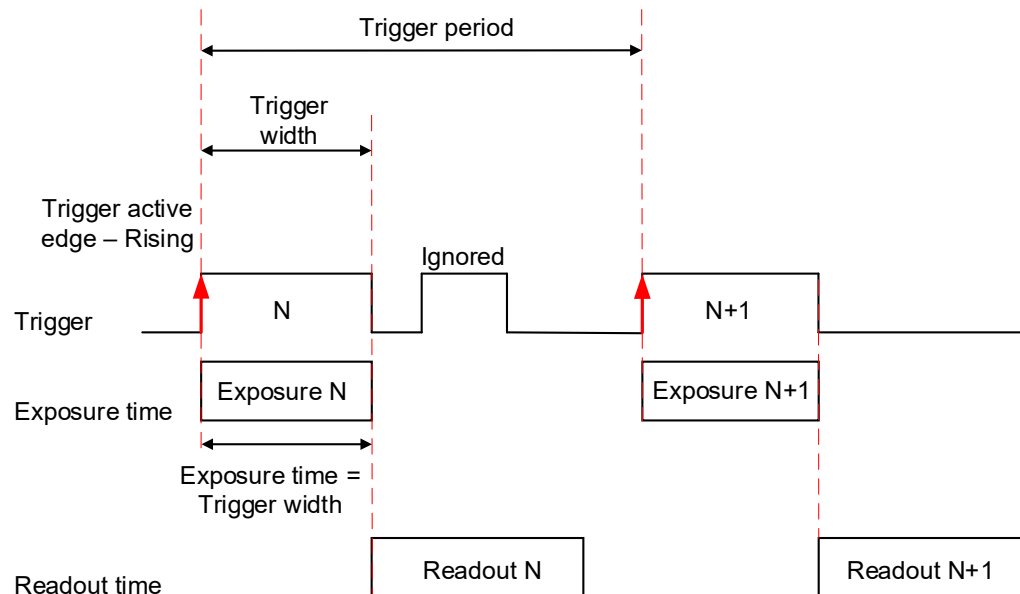
TriggerFilterTime, TriggerDelay, TriggerDebounceTime: **set if applicable**

ExposureMode: **Trigger Width**

Parameters of the external trigger pulse

Trigger width: $\geq 10 \mu\text{s}$

Trigger period (min) = Exposure time (max) + Readout time



The minimum trigger period is equal to the maximum exposure time plus the camera readout time:

$$\text{Trigger Period (min)} = \text{Exposure Time (max)} + \text{Readout Time,}$$

where the Readout Time is equal to the *CurrentFrameTime* (in free-running mode, with *AcquisitionFrameRateEnable* disabled).

If the next trigger pulse appears during the previous trigger period, the camera ignores it.

Fast Trigger Mode

In **Fast Trigger mode**, the exposure and readout are overlapped in a way that is similar to free-running (untriggered mode). Fast trigger mode depends upon a constant and stable trigger source so the camera can position the exposure period to conclude just as the previous frame readout ends. If the trigger period varies, the exposure varies with the trigger period, and uneven image illumination or wavering image brightness results.

An external timing pulse controls the start of the exposure when exposure control mode is **Timed**. The new exposure ends just as the readout of the current frame ends. The readout of the next frame begins with the next trigger. If the next trigger pulse appears during the previous trigger period, the camera ignores it.

Fast trigger mode, Exposure control is Timed

GenICam controls

Trigger Mode: **On**

Trigger Overlap: **On**

Trigger Source: **Line 1** (or Line2, Pulse Generator)

Trigger Activation: **Rising Edge** (or Falling Edge)

TriggerFilterTime, TriggerDelay, TriggerDebounceTime: – **set if applicable**

Exposure Mode: **Timed**

For manual exposure control:

Exposure Time: **User-specified** (Min. = 36 μ s; Max = Readout time)

ExposureAuto: **Off**

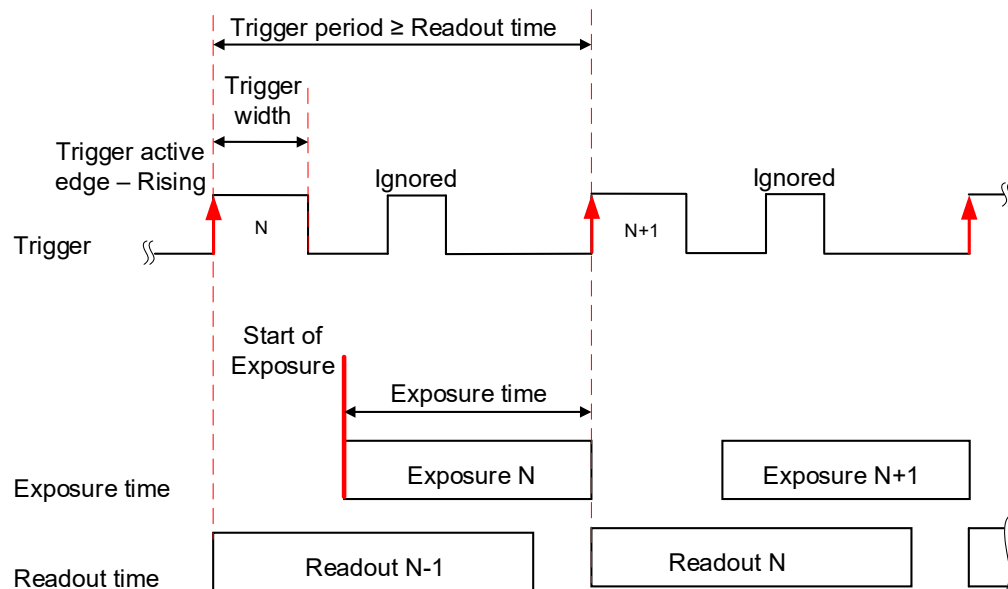
For Automatic exposure control:

ExposureAuto: **Continuous** (or Once)

Parameters of the external trigger pulse:

Trigger width: $\geq 10 \mu$ s

Trigger period (min) = Readout time



You can adjust the exposure duration to be equal to the external pulse width by setting the exposure control mode to **Trigger Width**. The new exposure begins with the next trigger pulse during the readout of the current frame.

Fast trigger mode, Exposure control is Trigger Width

GenICam controls

TriggerMode: **On**

TriggerOverlap: **On**

TriggerSource: **Line 1** (or Line2, Pulse Generator)

TriggerActivation: **Rising Edge** (or Falling Edge)

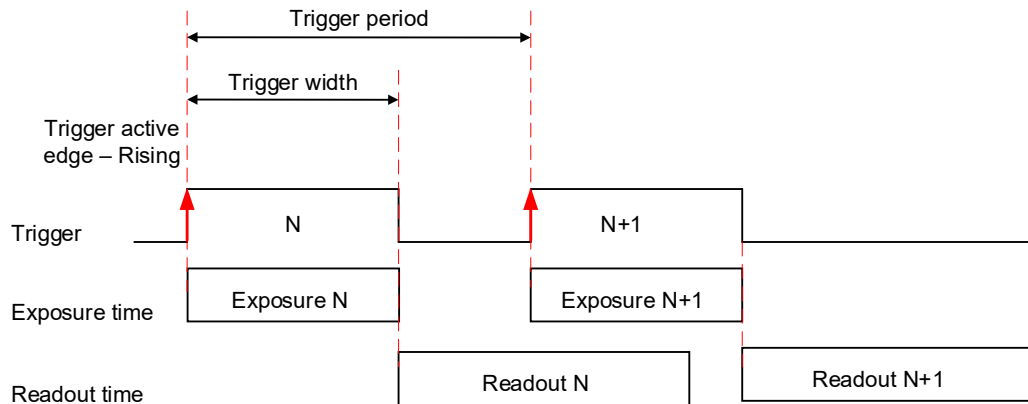
TriggerFilterTime, TriggerDelay, TriggerDebounceTime: **set if applicable**

ExposureMode: **Trigger Width**

Parameters of the external trigger pulse

Trigger width: $\geq 10 \mu\text{s}$

Trigger period: \geq Readout time



Trigger Sources

The camera allows for four sources for triggering: external Line1 or Line2, internal (pulse generator), and software. The minimum trigger pulse is 10 microseconds.

- **Line 1** – hardware Input Line GP Input1 (Trigger 1) is used as external source for the trigger signal.
- **Line 2** – hardware Input Line GP Input2 (Trigger 2) is used as external source for the trigger signal.
- **Pulse Generator** – trigger source is generated by camera's internal Pulse Generator.
- **Software** – the camera expects a computer to send a command to the camera for generating one short trigger pulse. You can trigger the camera by clicking the GUI Software Trigger button or by sending the GenICam Trigger Software command.

Configuring the Trigger

To configure the camera to work in **trigger mode**, follow the steps below:

1. Turn off the camera image acquisition.
2. In the Acquisition Control menu, set *TriggerMode* to **On**.
3. Set *TriggerOverlap* to either **Readout** for the camera to work in Fast Trigger mode or to **Off** for the camera to work in Standard Trigger mode.
4. Select *TriggerSource*:
 - If *TriggerSource* is either Line1 (Input1) or Line2 (Input2), configure the external trigger signal source using *LineInverter* feature.
 - If *TriggerSource* is PulseGenerator, configure the camera's internal pulse generator (see section Pulse Generator) and make sure that the *PulseGenEnable* setting is checked.
 - If *TriggerSource* is Software, you do not need to configure a signal source. The camera generates one short trigger pulse when you click the GUI Software Trigger button or send the GenICam™ Trigger Software command.
5. For *TriggerActivation* setting, select what edge (**Rising** or **Falling**) will be used for triggering.

NOTE *

If the *TriggerActivation* is RisingEdge and *ExposureMode* is set to TriggerWidth, the exposure duration will be the time the trigger stays high.

If *TriggerActivation* is FallingEdge and the *ExposureMode* is set to TriggerWidth, the exposure time will last as long as the trigger stays low.

Set *TriggerActivation* to FallingEdge if the camera works in Fast trigger mode (*TriggerOverlap* is set to Readout) with a trigger pulse width changing over time (*ExposureMode* is set to TriggerWidth).

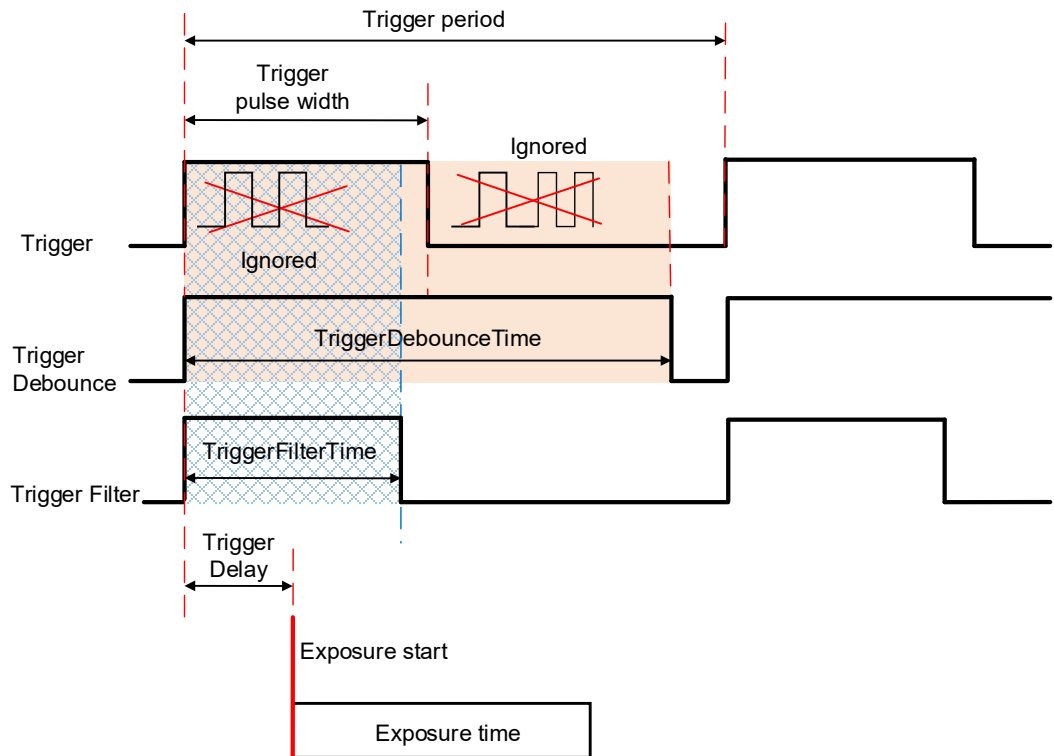
6. If applicable, set *TriggerFilterTime*, *TriggerDebounceTime*, *TriggerDelay* to desired values. The *TriggerFilterTime* and *TriggerDebounce* features are used to prevent false triggering when a trigger signal is being generated by an external source mapped to the camera's Input 1 or Input 2.

TriggerFilterTime

Defines the input trigger signals minimum pulse width. By setting the *TriggerFilterTime* to a value slightly less than the input signal's pulse width, the camera will reject any noise with pulse widths less than the *TriggerFilterTime* setting.

<i>TriggerDebounceTime</i>	Defines the time period following a triggering event in which no additional triggers will be accepted by the camera. Always set the <i>TriggerDebounceTime</i> to a value higher than the trigger signal's pulse width. The camera filters out interfering signals once the trigger pulse ends. The camera ignores any pulses during the <i>TriggerDebounceTime</i> after receiving the trigger signal.
<i>TriggerDelay</i>	Defines the time between the beginning of the trigger pulse and the beginning of the exposure. The camera captures an image with some delay after the trigger event.

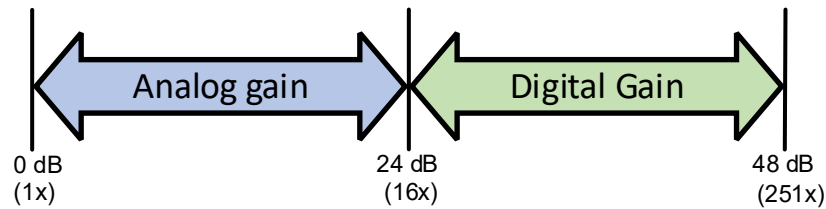
Trigger pulse width: $\geq 10 \mu\text{s}$
TriggerFilterTime: Recommended value $\leq 75\%$ of the Trigger pulse width
 Max. *TriggerFilterTime* = 65535 μs
 Max. *TriggerDebounceTime* = 65535 μs
 Max. *TriggerDelay* = 16000000 μs



Video Amplifier Gain and Offset

Image Sensor's Analog and Digital Gain

The image sensor allows you to apply up to 48 dB of gain to the image prior to A/D conversion. The first 24 dB of gain is analog gain and some improvement in noise performance may result. The camera applies the last 24 dB of gain digitally, which affects both signal and noise equally.



Digital Gain

Digital gain can be varied from 1x (0 dB) to 4x (12 dB) with a precision of $\sim 0.00097x$ using the raw (fine) gain control. There are 3,092 gain steps from 1x gain to 4x gain. Each step increases the gain by 0.001. Digital Gain does not provide any improved contrast and should be used cautiously.

Black Level Auto-calibration and Offset

The camera automatically adjusts black level based on measurements of the dark reference lines at the start of each frame. Imperx recommends leaving the *BlackLevelAuto* engaged (Continuous). If *SensorBlackLevelRecommended* disabled (set to false), you can set the *BlackLevel* manually and adjust it from 0 to 4095 counts. Black level will vary with temperature and gain.

Data Output Format

The image sensor digitization is set automatically based on the *Pixel Format* setting. A *Pixel Format* of 8- or 10-bits enables 10-bits sensor digitization while *Pixel Format* of 12-bits sets sensor digitization to 12-bits.

With 8-bit output, the camera uses the standard bit reduction process and truncates the least significant bits as described below.

12-bits sensor digitization

If the camera is set to output 12-bit data, sensor data bits map directly to D0 (LSB) to D11 (MSB).

MSB		Camera Output – 12 bits								LSB	
D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
P11	P10	P9	P8	P7	P6	P5	P4	P3	P2	P1	P0

10-bits sensor digitization

If the camera is set to output 10-bit data, sensor data bits map directly to D0 (LSB) to D9 (MSB).

MSB		Camera Output – 10 bits						LSB	
D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
P9	P8	P7	P6	P5	P4	P3	P2	P1	P0

If the camera is set to output 8-bit data, sensor most significant data bits (P2 to P9) map to D0 (LSB) to D7 (MSB).

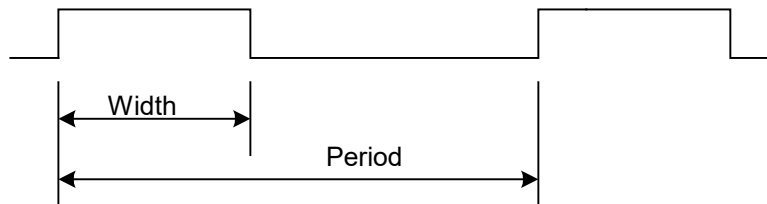
MSB		Camera Output – 8 bits						LSB	
D7	D6	D5	D4	D3	D2	D1	D0	-	-
P9	P8	P7	P6	P5	P4	P3	P2	P1	P0

Pulse Generator Settings

The camera has a built-in pulse generator that you can program to generate a discrete sequence of pulses or a continuous sequence. You can use the pulse generator as a trigger signal or map it to one of the outputs. You can set the discrete number of pulses from 1 to 65535 with a step of 1 or configure the pulse generator to work in continuous mode.

You can also set the following options:

- **Granularity** – Indicates the number of clock cycles used for each increment of the width and the period. Four possible options are available: x1, x10, x100, and x 1000.
- **Width** – Specifies the amount of time (determined by the granularity) the pulse remains at a high level before falling to a low level.
- **Period** – Indicates the amount of time (also determined by the granularity) between consecutive pulses.



Input / Output Control

The camera supports two inputs and two outputs (TTL and opto-isolated):

Input / Output #	Pin #	Description	Voltage/Current
Input 1	Pin 8 and Pin10 (Return)	Opto-isolated	Voltage 3.3–24 V, Current (min) 3.3 mA
Input 2	Pin 9 and Pin 11 (Return)	TTL/LVTTL	Voltage 5 V (TTL) or 3.3 V (LVTTL) Current (max) 2.0 mA
Output 1	Pin 7 and Pin 6 (Return)	TTL	Voltage 5.0 V (TTL) Current (max) 8.0 mA
Output 2	Pin 12 and Pin 5 (Return)	Opto-isolated	Voltage (max) 25 V Current (max) 50 mA

You can map Input 1 or Input 2 to the camera trigger source by following the steps 1 – 6 in the section [Configuring the Trigger](#). In Step 4, set *TriggerSource* to **Line 1** (Input1) or **Line 2** (Input2) respectively.

You can invert the input signal by using *LineInverter* setting in the Digital IO Control menu:

1. Select Input1 or Input2 in *LineSelector*.
2. Check the *LineInverter* box.

You can map one of nine signals to either Output 1 or Output 2 in the Digital IO Control menu:

1. Set *LineSelector* to **Output1** or **Output2**.
2. Select output signal in *LineSource* menu (refer to the section [Strobe and Synchronization Controls](#)).
3. You can invert the output signal by checking the *LineInverter* box.
4. If applicable, enable a strobe and specify its width, delay, and reference (for more information, refer to the section [Configuring the Strobe in Free-Running Mode](#) or [Configuring a Strobe in Trigger Mode](#)).

Strobe and Synchronization Controls

The camera allows you to synchronize your system from several references. You can synchronize with the trigger input, the start, middle or end of exposure, or the internal pulse generator signals.

Output Signal	Description
ExposureStart	A 10-microsecond pulse indicating the beginning of the exposure
ExposureEnd	A 10-microsecond pulse indicating the end of the exposure
MidExposure	A 10-microsecond indicating the middle of the exposure
ExposureActive	The output signal is active for the duration of exposure time
TriggerActual	Maps the input trigger pulse to the output with no delay
TriggerDelayed	Maps the input trigger pulse to the output with trigger delay
PulseGenerator	Maps the internal pulse generator waveform to the output
Strobe1	Maps the Strobe 1 signal to the corresponding external output
Strobe2	Maps the Strobe 2 signal to the corresponding external output

The camera provides signals indicating the start of exposure, mid-exposure, and end of exposure. These signals have a fixed duration of 10 microseconds. If a longer pulse period is required, the strobe feature can be used.

The camera provides two strobes for synchronization with an external light source, other cameras, or peripheral devices. You can position each strobe pulse within the entire frame-timing period with a precision of 1.0 microsecond.

You can position a strobe pulse with the following references, depending on the camera mode:

Camera Mode	Strobe Reference
Free-running mode	Start of Exposure, Start of Readout
Trigger mode (Standard and Fast)	Start of Exposure, Start of Readout, Trigger

Configuring the Strobe in Free-Running Mode

In **free-running mode**, you can set the strobe pulse duration (*StrobeWidth*) and the delay (*StrobeDelay*) with respect to the start of the exposure or the start of the readout period. The strobe period is equal to the frame time. You can map a strobe to either Output 1 (TTL) or Output 2 (opto-isolated).

Positioning the Strobe1 with a Reference to the Exposure Start

1. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
2. Set *LineSource* to Strobe1.
The strobe is mapped to the output selected under *LineSelector*.
3. If necessary, check the *LineInverter* box.
It inverts the output signal.
4. Set *Strobe1Reference* to Start of Exposure.
5. Set *Strobe1Enable* to On.
6. If necessary, set *Strobe1Delay*.
Without a delay, the strobe occurs simultaneously with the start of exposure.
7. Set *Strobe1Width* to a desired value.

Positioning the Strobe2 with a Reference to the Readout Start

1. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
2. Set *LineSource* to Strobe2.
The strobe is mapped to the output selected under *LineSelector*.
3. If necessary, check the *LineInverter* box.
It inverts the output signal.
4. Set *Strobe2Reference* to Start of Readout.
5. Set *Strobe2Enable* to On.
6. If necessary, set *Strobe2Delay*.
Without a delay, the strobe occurs simultaneously with the start of exposure.
7. Set *Strobe2Width* to a desired value.

Strobes Positioned with Respect to the Start of Exposure and Readout, Free-running Mode

GenICam controls

TriggerMode: **Off**

LineSelector: **Output1** (or Output2)

LineSource: **Strobe1** (or Strobe2)

Strobe1Reference: **Exposure**

Strobe1Enable: **On**

Strobe1Width: **User-specified** (in μs)

Strobe1Delay: **User-specified** (Min. = 10 μs)

Strobe2Reference: **Readout**

Strobe2Enable: **On**

Strobe2Width: **User-specified** (in μs)

Strobe2Delay: **User-specified** (Min. = 10 μs)

Exposure Mode: **Timed** (or Off)

For manual exposure control:

Exposure Time: **User-specified** (Min. = 36 μs ; Max = Readout time)

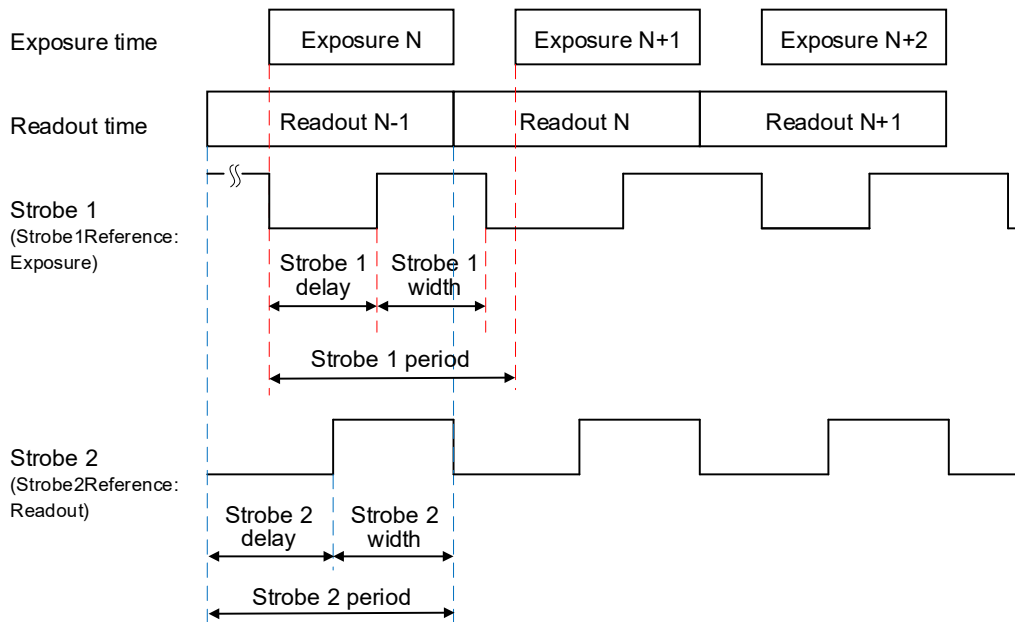
ExposureAuto: **Off**

For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

Parameters of the strobe signal

Strobe period = frame time



Configuring a Strobe in Trigger Mode

If the camera is in the **Trigger mode** (Standard or Fast Trigger), you can set the strobe pulse duration and the delay with respect to the trigger pulse active edge, start of the exposure, or start of the readout period. The strobe period equals the trigger period.

Positioning the Strobe1 with a Reference to Trigger or Exposure Start

1. Make sure that *TriggerMode* is On in the Acquisition Control menu.
2. Select a *TriggerSource* and *TriggerActivation*.
3. Set *TriggerDelay* to 0. If applicable, set *TriggerFilterTime* and *TriggerDebounce* to desired values.
4. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
5. Set *LineSource* to Strobe1.
The strobe is mapped to the output selected under *LineSelector*.
6. If necessary, check the *LineInverter* box.
It inverts the output signal.
7. Set *Strobe1Reference* to Trigger (or Start of Exposure).
8. Set *Strobe1Enable* to On.
9. If necessary, set *Strobe1Delay*.
Without a delay, the strobe occurs simultaneously with the trigger active edge (start of exposure).
10. Set *Strobe1Width* to a desired value.

Positioning the Strobe2 with a Reference to the Readout Start

1. Make sure that *TriggerMode* is On in the Acquisition Control menu.
2. Select a *TriggerSource* and *TriggerActivation*.
3. If applicable, set *TriggerDelay*, *TriggerFilterTime* and *TriggerDebounce* to desired values.
4. In the DigitalIOControl menu, set *LineSelector* to Output1 (TTL) or Output2 (opto-isolated).
5. Set *LineSource* to Strobe2.
The strobe is mapped to the output selected under *LineSelector*.
6. If necessary, check the *LineInverter* box.
It inverts the output signal.
7. Set *Strobe2Reference* to Start of Readout.
8. Set *Strobe2Enable* to On.

9. If necessary, set *Strobe2Delay*.
Without a delay, the strobe occurs simultaneously with the start of exposure.
10. Set *Strobe2Width* to a desired value.

Strobes Positioned with Respect to a Trigger, Exposure Start, or Readout Start
Standard Trigger Mode

GenICam controls

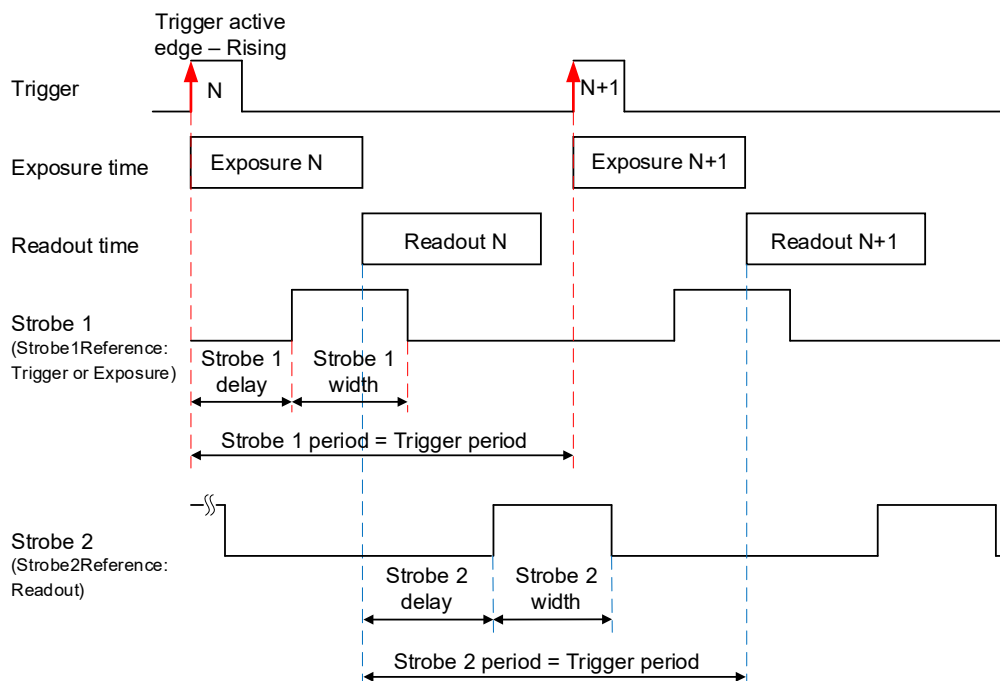
TriggerMode: **On**
 TriggerOverlap: **Off**
 TriggerSource: **Line 1** (or Line2, Pulse Generator)
 TriggerActivation: **Rising Edge** (or Falling Edge)
 TriggerDelay: **0** (no delay)
 TriggerFilterTime, TriggerDebounceTime: **set if applicable**

LineSelector: **Output1** (or Output2)
 LineSource: **Strobe1** (or Strobe2)
 Strobe1Reference: **Trigger** (or Exposure)
 Strobe1Enable: **On**
 Strobe1Width: **User-specified** (in μs)
 Strobe1Delay: **User-specified** (Min. = 10 μs)
 Strobe2Reference: **Readout**
 Strobe2Enable: **On**
 Strobe2Width: **User-specified** (in μs)
 Strobe2Delay: **User-specified** (Min. = 10 μs)

Exposure Mode: **Timed**
For manual exposure control:
 Exposure Time: **User-specified** (Min. = 36 μs ; Max = Readout time)
 ExposureAuto: **Off**
For automatic exposure control (AEC):
 ExposureAuto: **Continuous** (or Once)

Parameters of the strobe signal

Strobe period = Trigger period



Strobe 1 is positioned with respect to the exposure start with a trigger delay. The camera is in Standard Trigger mode with Timed Exposure Control.

**Strobes Positioned with Respect to the Exposure Start
Standard Trigger Mode**

GenICam controls

TriggerMode: **On**
 TriggerOverlap: **Off**
 TriggerSource: **Line 1** (or Line2, Pulse Generator)
 TriggerActivation: **Rising Edge** (or Falling Edge)
 TriggerDelay: **User-specified** (Min.= 10 μ s)
 TriggerFilterTime, TriggerDebounceTime: **set if applicable**

LineSelector: **Output1** (or Output2)
 LineSource: **Strobe1** (or Strobe2)
 Strobe1Reference: **Exposure**
 Strobe1Enable: **On**
 Strobe1Width: **User-specified** (in μ s)
 Strobe1Delay: **User-specified** (in μ s)

Exposure Mode: **Timed**

For manual exposure control:

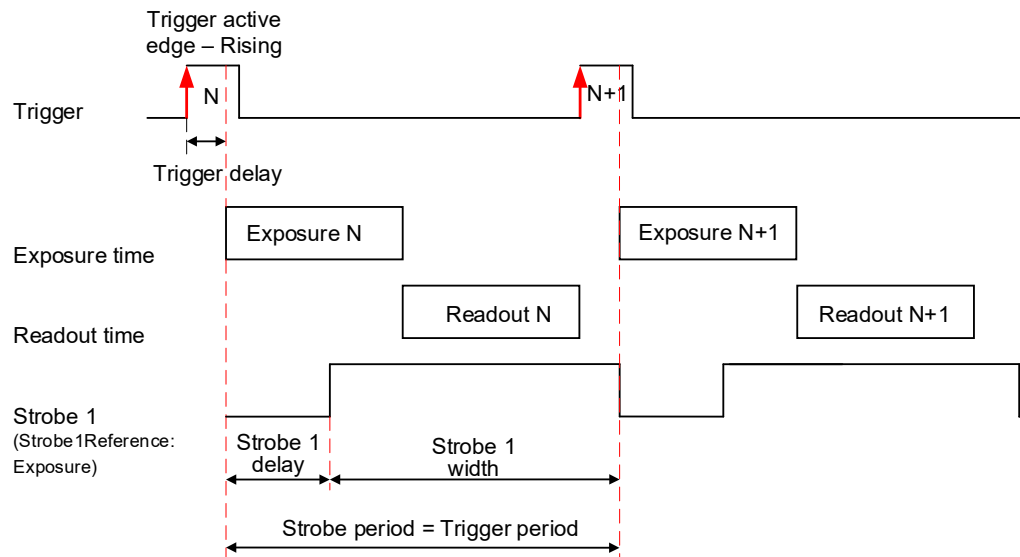
Exposure Time: **User-specified** (Min.= 36 μ s; Max = Readout time)
 ExposureAuto: **Off**

For automatic exposure control (AEC):

ExposureAuto: **Continuous** (or Once)

Parameters of the strobe signal

Strobe period = Trigger period



If your application requires activating a light source before the start of the exposure period, you can use *StrobeReference* and *StrobeDelay* settings to position the strobe to occur earlier than the exposure. To configure the strobe, follow the steps below:

1. Make sure that *TriggerMode* is **On** and *TriggerDelay* is set to a desired value in the Acquisition Control menu.
The Exposure starts with the delay after the trigger event.
2. Set *StrobeReference* to **Trigger**. The strobe occurs simultaneously with the trigger active edge.
3. Set *StrobeDelay* to a value lower than the *TriggerDelay* duration.

4. Set *StrobeWidth* to a desired value.

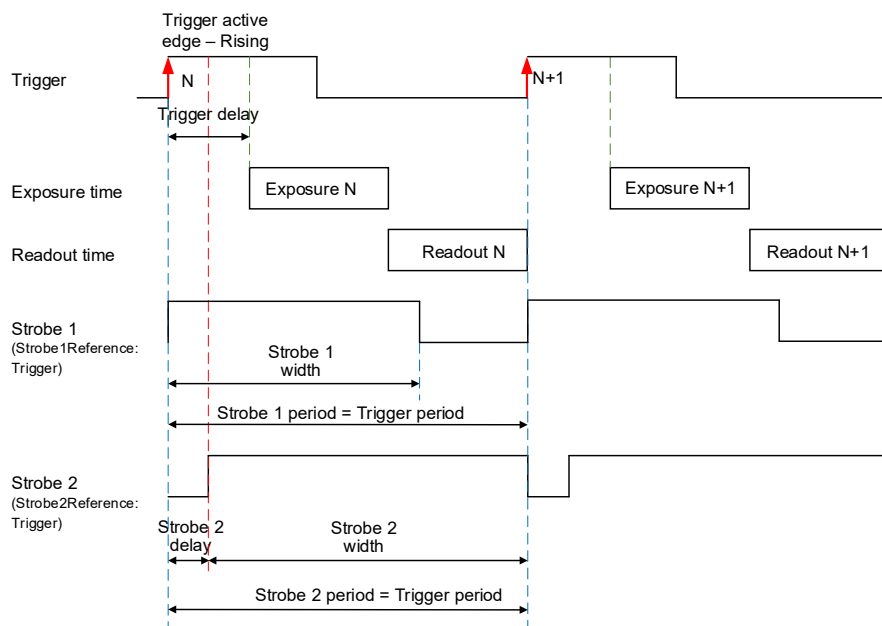
Strobes Positioned with Respect to the Trigger
Standard Trigger Mode

GenICam controls
 TriggerMode: **On**
 TriggerOverlap: **Off**
 TriggerSource: **Line 1** (or Line2, Pulse Generator)
 TriggerActivation: **Rising Edge** (or Falling Edge)
 TriggerDelay: **User-specified** (Min. = 10 μ s)
 TriggerFilterTime, TriggerDebounceTime: **set if applicable**

LineSelector: **Output1** (or Output2)
 LineSource: **Strobe1** (or Strobe2)
 Strobe1Reference: **Trigger**
 Strobe1Enable: **On**
 Strobe1Width: **User-specified** (in μ s)
 Strobe1Delay: **0** (no delay)
 Strobe2Reference: **Trigger**
 Strobe2Enable: **On**
 Strobe2Width: **User-specified** (in μ s)
 Strobe2Delay: **User-specified** (in μ s)

Exposure Mode: **Timed**
For manual exposure control:
 Exposure Time: **User-specified** (Min. = 36 μ s; Max = Readout time)
 ExposureAuto: **Off**
For automatic exposure control (AEC):
 ExposureAuto: **Continuous** (or Once)

Parameters of the strobe signal
 Strobe period = Trigger period

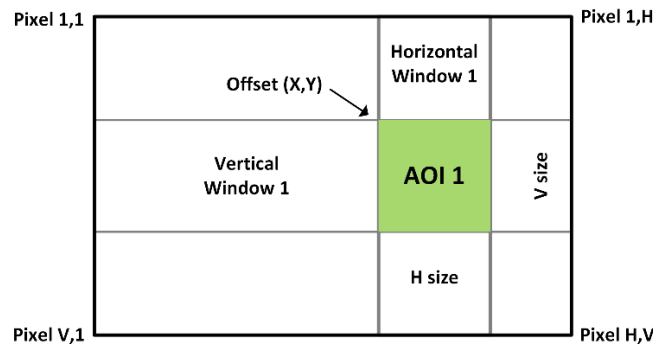


Area of Interest

For some applications, you might not need the entire image, but only a portion of it. To accommodate this requirement, the Cheetah camera allows you to create one Region of Interest (ROI), also known as an Area of Interest (AOI).

Horizontal and Vertical Window

Set the starting and ending point for each AOI independently in the horizontal direction (Horizontal Window) and the vertical direction (Vertical Window) by setting the window (H & V) offset and (H & V) size. The horizontal dimension is limited to multiples of 32 pixels, and the vertical dimension is limited to multiples of 4 pixels. In normal operation, the AOI defines the number of columns and rows output. The maximum horizontal window size (H) and the vertical window size (V) are determined by the camera’s image full resolution.



NOTE * For color cameras with AOI enabled, use an even number for Offset X and Offset Y to achieve proper color reconstruction and white balance.

Factors Impacting Frame Rate

The camera frame rate depends upon a number of variables including the exposure time, number of rows and columns in the AOI, and the bandwidth of the output interface.

AOI size: Camera frame rate increases by decreasing either the number of columns or number of rows read out. Changing the number of rows read out causes the largest change in frame rate.

Exposure Time: In free-running or Fast trigger mode, the camera overlaps the exposure time and image readout so frame rate has no dependence on exposure time. In Standard trigger mode, however, the exposure and readout time do not overlap, and long exposure times will decrease frame rate.

Line time: This is the time required to read out one line from CMOS sensor. Increasing the line time decreases the camera frame rate and extends exposure time. Please note that the extended line time decreases bandwidth usage.

Decimation: The camera supports both binning and sub-sampling decimation to reduce the output resolution. Binning and sub-sampling increase the sensor frame rate. However, sub-sampling offers the largest frame rate improvement by reducing the number of rows and columns read out from the image sensor. Binning and sub-sampling provide about a 2x to 3x increase in frame rate.

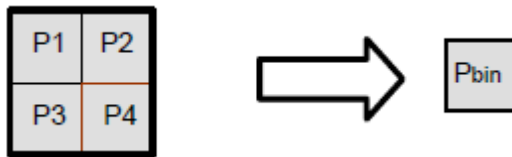
Binning and Subsampling Decimation

Binning

The principal objective of the binning function is to reduce the image resolution with better final image quality than a subsampling function. Binning reduces the output resolution by summing several pixels together and has the advantage of reducing aliasing, increasing signal-to-noise ratio (SNR). Subsampling – as opposed to binning – has the advantage of increasing the output frame rate by reducing the number of rows read out, but also can introduce aliasing in the final image. Subsampling, however, increases the output frame rate more than binning.

The following graphic illustrates the concept of 4:1 binning for a monochrome image sensor. The values of pixels P1, P2, P3 and P4 are summed together resulting in a single larger pixel output value.

The binning feature can be used on the full resolution image or within any area of interest.



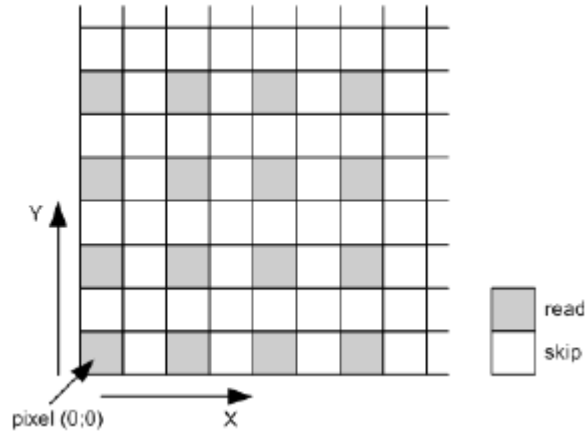
NOTE ⚠ You cannot apply both binning and subsampling decimation simultaneously.
Color cameras do not support binning.

Subsampling Decimation

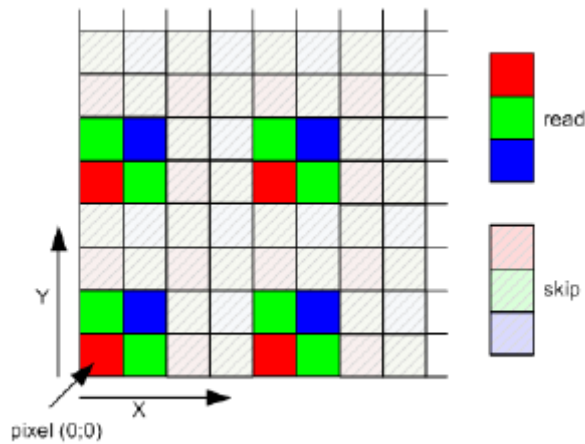
Subsampling reduces the number of pixels output by reducing the output frame size but maintains the full field of view. If an area of interest (AOI) is selected, then the field of view of the AOI is maintained.

The cameras employ a “keep one pixel, skip one pixel” sequence. When enabled in both x and y, every other pixel within a line is retained, and every other line within the image is retained.

Monochrome subsampling:



Color subsampling:



Lookup Tables

The user-defined LUT (Lookup Table) feature transforms any 12-bit video data into any other 12-bit value. For the 10-bit sensor digitization, the camera multiplies the 10-bit pixel data by 4 to get 12-bit pixel data for input into the 12-bit LUT. After the 12-bit LUT transforms the data, the camera divides the 12-bit data by 4 to get 10-bit pixel values for output to the camera interface.



The camera supports a Gamma control feature and four separate LUTs. All LUTs are available for modifications. You can generate and upload a custom LUT using the Imperx Upload Utility (see [Uploading the LUT File](#)).

You can control the image luminance by setting the Gamma control or/and by enabling one of the LUT. When both Gamma and LUT enabled, the camera implements the Gamma control first and then applies the LUT.

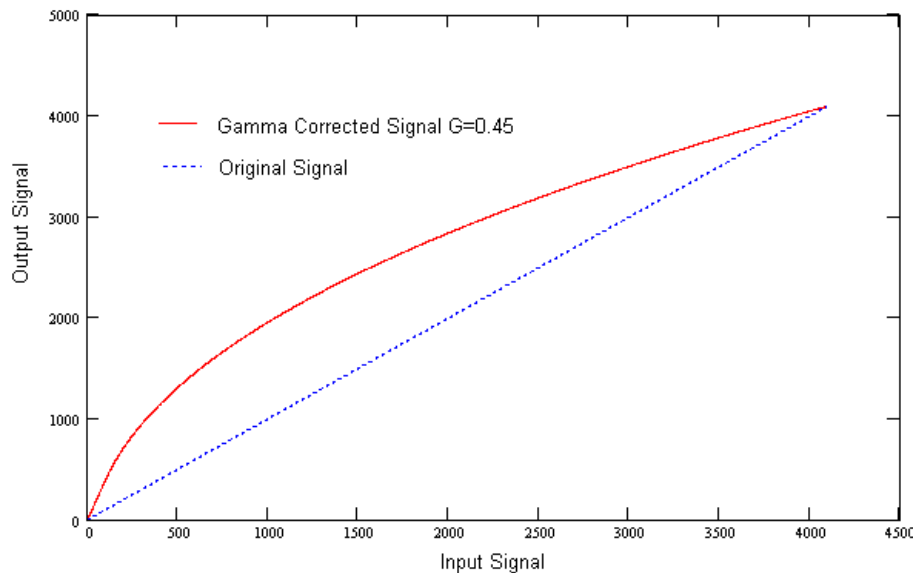
Factory LUTs

Each LUT consists of 4096 entries, with each entry being 12 bits wide. LUT1 and LUT3 are factory programmed with a standard Gamma 0.45, LUT2 and LUT4 are pre-programmed with negative LUT ($LUT_{OUTPUT} = 4095 - LUT_{INPUT}$).

The Gamma 0.45 LUT uses the following formula:

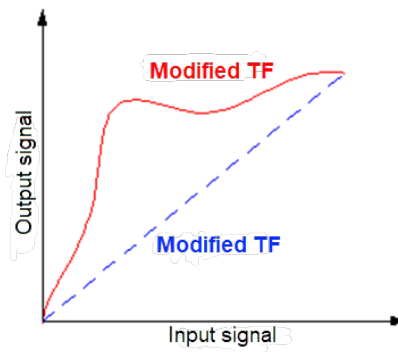
$$LUT_{OUTPUT} \text{ (ADU with 12 bpp)} = 4095 * [(LUT_{INPUT}/4095)^{0.45}]$$

For example, if the LUT_{INPUT} is 1024 ADU (12 bpp), then LUT_{OUTPUT} is $4095 * (1024/4095)^{0.45} = 2195$.



User Defined LUT

You can define any 12-bit to 12-bit transformation as a user LUT and upload it to the camera using Imperx Upload Utility (see [Uploading the LUT File](#)). You can specify a transfer function to match the camera's dynamic range to the scene's dynamic range. There are no limitations to the profile of the function. The LUT must include all possible input values (0 to 4095) (refer to the [Appendix C: Look Up Tables](#)).



Hot and Defective Pixel Correction

A CMOS imager is composed of a two-dimensional array of light sensitive pixels. In general, most of the pixels have similar sensitivity. However, some pixels deviate from the average pixel sensitivity and are called *defective pixels* and *hot pixels*.

Defective pixels (also known as *dead pixels*)—these are pixels whose sensitivity deviates due to fluctuations in the CMOS manufacturing process and materials. Two types of defective pixels are possible:

- **Dark** – a pixel whose sensitivity is lower than the sensitivity of the adjacent pixels. In some cases, this pixel will have no response (completely dark).
- **Bright** – a pixel whose sensitivity is higher than the sensitivity of the adjacent pixels. In some cases, this pixel will have full response (completely bright).

Hot pixels – these are pixels that in normal camera operation behave as normal pixels (sensitivity equal to one of the adjacent pixels). But during long exposures or at elevated temperatures, the pixel becomes far brighter than the average of the pixels surrounding it. In some cases, the pixel becomes so bright that it saturates.

At the factory, final testing identifies and stores maps of both hot and defective pixels. Enabling *DefectPixelCorrection* and *BadPixelCorrection* using the Factory option, corrects hot and defective pixels using the Factory map.

The camera employs *static* pixel maps to correct up hot and defective pixels. During factory testing, engineers identify the coordinates of hot and defective pixels. They create a map file listing the pixel coordinates of these pixels by row and column, and the camera corrects the hot and defective pixels found at these coordinates. The map file downloads into the camera's non-volatile memory.

When Factory or User correction is enabled, the camera compares each pixel's coordinates with entries in the pixel map. If a match is found, the camera corrects the defective pixel.

You can create your own Hot Pixel Map (HPM) or Defective Pixel Map (DPM) file and upload it using the Imperx Upload Utility application (refer to the [Appendix B](#) for more information).

Flat Field Correction

The camera uses a factory installed flat field correction (located in FFC0) algorithm to correct some of the image sensor's non-uniformity. You can upload your own FFC table to one of the FFC1 – FFC8 tables using Imperx Upload Utility. While not recommended, you can disable the FFC.

Test Image Pattern

The camera can output several test images to verify the camera's general performance and connectivity to the computer. This ensures that all the major modules in the hardware are working properly and the connection between your computer and camera is synchronized, that is, the image framing, output mode, communication rate, and so on are properly configured. Note that test image patterns do not exercise and verify the image sensor functionality. The following table show a list of test images available.

Test pattern	Description
Off	Image is coming from the sensor
GreyHorizontalRamp	Image is filled horizontally with an image that goes from the darkest possible value to the brightest
GreyVerticalRamp	Image is filled vertically with an image that goes from the darkest possible value to the brightest
GreyHorizontalRampMoving	Image is filled horizontally with an image that goes from the darkest possible value to the brightest and that moves horizontally from left to right at each frame.
GreyVerticalRampMoving	Image is filled vertically with an image that goes from the darkest possible value to the brightest and that moves vertically from top to bottom at each frame.
FlatField	Displays a constant grey value.
lpxGevPattern	GEV engine firmware generate an image.

Automatic White Balance

The camera provides white balance options for controlling image color under different lighting conditions. You can load the camera with your preferred white balance coefficients or let the camera determine the color coefficients one time or continuously (auto).

AWB Mode	Description
Off	AWB is disabled and a manual control is on. The camera applies the correction coefficients you enter using the <i>BalanceRatioSelector</i> and <i>BalanceRatio</i> controls.
Once	The camera analyzes one image frame, calculates only one set of coefficients, and corrects all subsequent frames with this set of coefficients.
Continuous	The camera analyzes every frame, derives a set of correction coefficients for each frame, and applies them to the next frame. You can set a tracking speed to be from 1 to 64 with 1 being the slowest and 64 the fastest.

To compensate for color shift, the Green channel is used as a reference and the Red and Blue channel gains are changed to match the Green channel. For example, to increase the Red channel gain by 75%, set the Red *BalanceRatio* to 1.75x. The camera applies 75% more gain to the Red channel than to the Green.

Manual Control over the Correction Coefficients (AWB mode: Off)

To adjust the Red and Blue channel gain coefficients with respect to Green (the reference), use the control *BalanceRatioSelector* to point to the color (Red or Blue) whose gain should be adjusted. Then *BalanceRatio* control is used to set a gain value between 0.25x to 4.00x for the selected color. The Green channel gain is always set to 1.

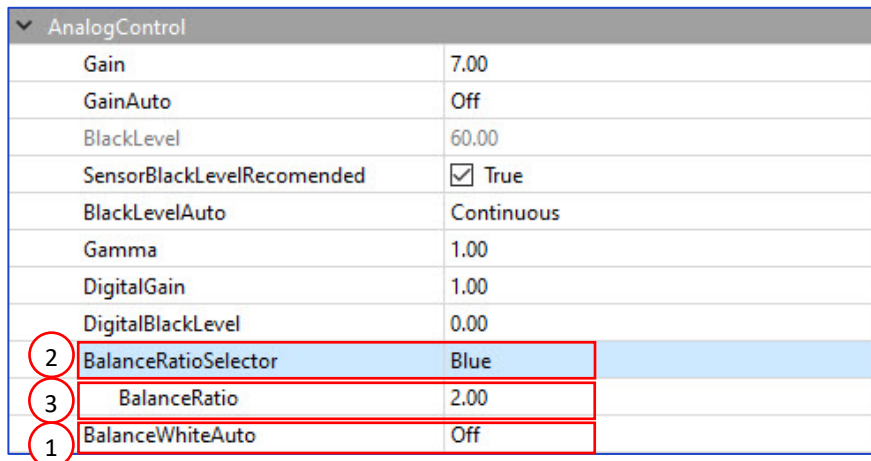
BalanceRatio value	Red/Blue channel gain
from 0.25x to 0.99x	the channel gain decreases
from 1.01x to 4.00x	the channel gain increases
1.00x	the gain does not change

To disable Auto-White Balance, set *BalanceRatio* to 1.00x for both Red and Blue channel gains.

EXAMPLE

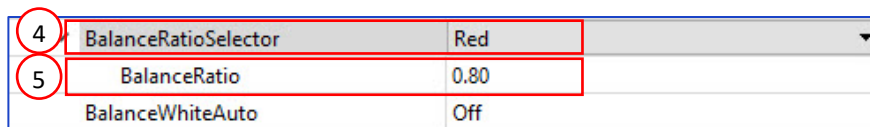
To set Blue channel gain with respect to Green to 2x and set Red channel gain to 0.8x:

1. On **AnalogControl** panel, set *BalanceWhiteAuto* to **Off**.
2. Set *BalanceRatioSelector* to **Blue**.
3. Set *BalanceRatio* to 2.00.



AnalogControl	
Gain	7.00
GainAuto	Off
BlackLevel	60.00
SensorBlackLevelRecomended	<input checked="" type="checkbox"/> True
BlackLevelAuto	Continuous
Gamma	1.00
DigitalGain	1.00
DigitalBlackLevel	0.00
2 BalanceRatioSelector	Blue
3 BalanceRatio	2.00
1 BalanceWhiteAuto	Off

4. Set **BalanceRatioSelector** to Red.
5. Set **BalanceRatio** to 0.80.



4 BalanceRatioSelector	Red
5 BalanceRatio	0.80
BalanceWhiteAuto	Off

6. Save this configuration to one of the User Sets (see section [Configuration Memory](#)).

AWB mode: Once

For the best color reproduction when the source has a stable spectral output, Imperx suggests illuminating a uniformly grey card with the intended source then using the **Once** option to determine the coefficients and then saving these coefficients into the camera and saving this configuration to one of the User Sets.

To get the best white balance coefficients when the spectral source is constant:

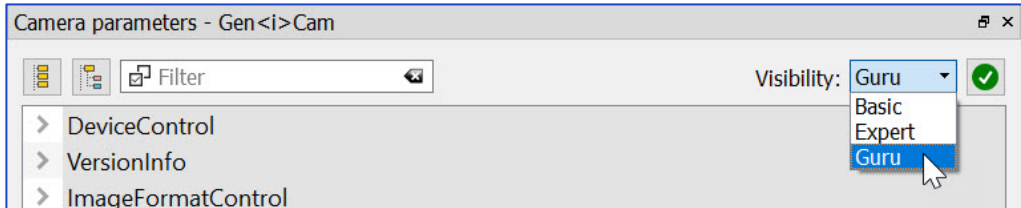
1. Image a grey or white target over the camera's entire field of view using the intended lighting source.
2. Select **Once** mode for the *BalanceWhiteAuto*. The Red and Blue coefficients appear in the *BalanceRatio* area.
3. Save this configuration to one of the User Sets (see section [Configuration Memory](#)).

AWB mode: Continuous

The camera automatically adjusts the Red and Blue channel gains when *BalanceWhiteAuto* is set to **Continuous**.

Canon Lens Control

Make sure that a switch on your Canon EOS EF lens is set to Auto (AF), and Visibility is set to Guru on the IpxPlayer GUI screen:



The camera initializes the lens upon power cycling. Check **Lens Controller Status** parameter. If the status is `InitLens_Done`, the initialization was successfully completed, and you can start adjusting the lens. If the initialization failed, issue **InitLens** command on Controller Setting screen.

Focus Control

1. For the camera to learn the range of the Canon lens’s Focus Encoder, issue the following sequence of commands:
 - a. Issue the *Canon Focus Near-Full* command.
 - b. Issue the *Reset Focus Encoder* command.
 - c. Issue the *Canon Focus Far-Full* command.
 - d. Issue the *Get Focus Encoder Status* command.
 - e. Issue the *Focus Set Max* command. The *Focus Max* parameter will be adjusted automatically to this value.

<ul style="list-style-type: none"> ▼ CanonLensControl <ul style="list-style-type: none"> > ControllerSettings <ul style="list-style-type: none"> ▼ Focus <table border="1"> <tr> <td>NearFull</td> <td>Execute</td> <td>a.</td> </tr> <tr> <td>FarFull</td> <td>Execute</td> <td>c.</td> </tr> <tr> <td>FocusStepValue</td> <td>1</td> <td></td> </tr> <tr> <td>NearStep</td> <td>Execute</td> <td></td> </tr> <tr> <td>FarStep</td> <td>Execute</td> <td></td> </tr> <tr> <td>FocusReqPosition</td> <td>0</td> <td></td> </tr> <tr> <td>SetFocusPosition</td> <td>Execute</td> <td></td> </tr> <tr> <td>FocusMax</td> <td>0</td> <td></td> </tr> <tr> <td>FocusSetMax</td> <td>Execute</td> <td>e.</td> </tr> <tr> <td>FocusEncoderStatus</td> <td>0</td> <td></td> </tr> <tr> <td>GetFocusEncoderStatus</td> <td>Execute</td> <td>d.</td> </tr> <tr> <td>ResetFocusEncoder</td> <td>Execute</td> <td>b.</td> </tr> </table> 	NearFull	Execute	a.	FarFull	Execute	c.	FocusStepValue	1		NearStep	Execute		FarStep	Execute		FocusReqPosition	0		SetFocusPosition	Execute		FocusMax	0		FocusSetMax	Execute	e.	FocusEncoderStatus	0		GetFocusEncoderStatus	Execute	d.	ResetFocusEncoder	Execute	b.
NearFull	Execute	a.																																		
FarFull	Execute	c.																																		
FocusStepValue	1																																			
NearStep	Execute																																			
FarStep	Execute																																			
FocusReqPosition	0																																			
SetFocusPosition	Execute																																			
FocusMax	0																																			
FocusSetMax	Execute	e.																																		
FocusEncoderStatus	0																																			
GetFocusEncoderStatus	Execute	d.																																		
ResetFocusEncoder	Execute	b.																																		

2. Set *FocusReqPosition* to a desired value.
3. Issue the *SetFocusPosition* command and the lens will move to the *FocusReqPosition* value. *FocusEncoderStatus* will be updated to reflect the new position

The Focus Encoder uses a Hall effect sensor and is not perfectly precise, so *FocusEncoderStatus* values can vary. It does not provide sufficiently accurate location information to change lens focus after power cycling and the error tends to increase with the number of focus movements. However, once the lens is focused, it will retain focus after repeated power cycling.

The *FocusEncoderStatus* is a signed binary value (2's complement). Negative values can result if the Focus Encoder position is close to the Near Full position. For example, a value of 65352 means negative 184 or 184 steps past the Near Full Position.

Iris Control

A Canon EF EOS lens provides an iris range in raw units and the camera reads out an iris range from a Canon lens in raw units upon issuing the *GetIrisRange* command. Each time the iris is changed, the camera calculates and returns the *CurrentFNumber* using the following formula:
 $CurrentFNumber = \sqrt{2}^{[(Raw\ unit/8) - 1]}$
 For example, if Raw unit = 32, then *CurrentFNumber* = 2.83.

Using XML features *IrisRequestedPositionRaw* and *SetIrisPosition*, you can set an aperture to a required value. The aperture will be changed with *IrisStepValue* until it is greater than or equal to the target position in raw units.

▼ CanonLensControl	
> ControllerSettings	
> Focus	
▼ Iris	
IrisRequestedPositionRaw	0
SetIrisPosition	Execute
CurrentFNumber	4.55515
OpenIrisFull	Execute
CloseIrisStep	Execute
OpenIrisStep	Execute
IrisStepValue	1
GetIrisRange	Execute
IrisMin	43
IrisMax	80
IrisRange	502B2B2B

Configuration Memory

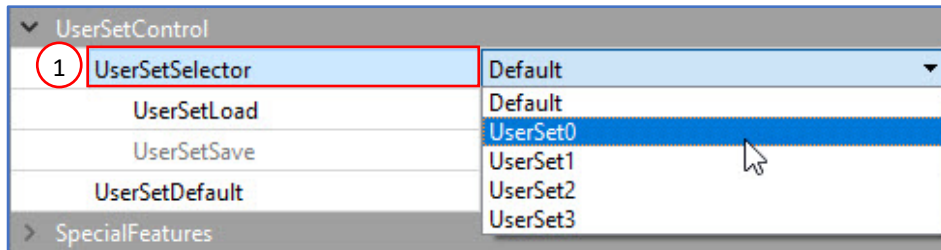
The camera has built-in configuration memory divided into six segments: Work Space, Factory Space (Default), User Space #0, #1, #2 or #3. The Work Space segment contains the current camera settings while the camera is powered up and operational. All camera registers are in this space. You can program these registers and change the camera configuration through these registers.

The Work Space is RAM based. All camera registers clear upon camera power-down. The Factory Space (Default) segment is ROM based, write protected, and contains the default camera settings. This space is available for read operations only. User Space #0, #1, #2 and #3 are non-volatile, flash-based, and used to store up to four user defined configurations or User Sets. Upon power up or software reset, the camera firmware loads the Work Space registers from the Factory Space (Default), User Space #0, #1, #2 or #3 as determined by a User Set Default Selector setting.

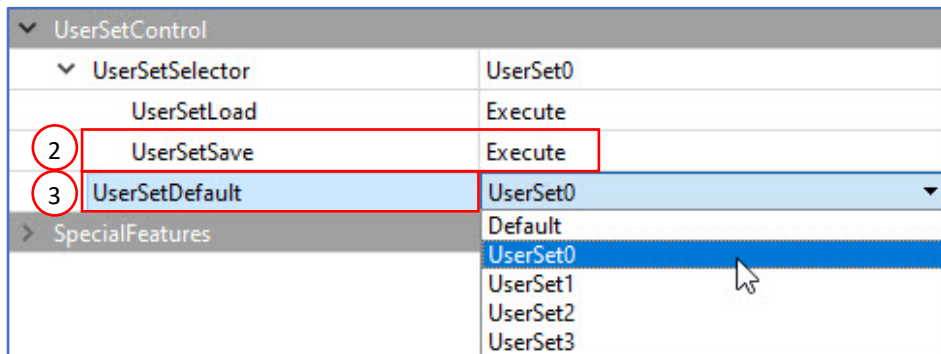
At any time, you can instruct the camera to load its Work Space with the contents of the Factory Space, User Space #0, #1, #2 or #3 by first using the *UserSetSelector* to point to the desired User Set then using the *UserSetLoad* command.

Similarly, you can instruct the camera to save the current Work Space settings into either User Space #0, #1, #2 or #3 by using the User Set Selector to point to the desired User Set and then using the User Set Save command:

1. In the **User Set Control** menu, point to one of the User Sets to store your configuration using the *UserSetSelector*.



2. Execute **UserSetSave** command to save your configuration to the camera’s non-volatile memory.
3. Select your User Set (must be the same as in step 2) in **UserSetDefault** menu. The camera loads and activates this User Set upon the next reset or upon power-up.



4. Power-cycle the camera for the changes to take effect.

The non-volatile parameter Flash memory also contains the Bad Pixel Map (BPM), Defective Pixel Map (DPM), 8 Flat Field Correction (FFC) tables, and 4 LUTs which you can load to the camera's internal memory upon enabling the corresponding camera feature. You can create custom LUT tables using the Imperx IPX Toolkit utility and upload these tables to the parameter Flash using the Imperx Upload Utility. Both the IPX Toolkit and IPX Upload Utility are available from the Imperx website <https://www.imperx.com/>.

Image Sensor Technology

General Information

A CMOS camera is an electronic device for converting light into an electrical signal. The C4440, C5440, and C6440 cameras contain Sony Pregius CMOS (Complementary Metal-Oxide Semiconductor) image sensors with 3.45-micron square pixels. The sensors have extremely low dark current and no visible fixed pattern noise, which has been the bane of traditional CMOS image sensors.

The Sony CMOS sensor consists of a two-dimensional array of sensitive elements called silicon photodiodes, also known as pixels. The photons falling on the CMOS surface create photoelectrons within the pixels. The number of photoelectrons is linearly proportional to the light level. Although the number of electrons collected in each pixel is linearly proportional to the light level and exposure time, the number of electrons created in the pixel during any fixed time period varies with the wavelength of the incident light.

When the camera reaches the desired exposure time, it shifts the charges from each pixel photodiode onto a storage register within the pixel, reads out one row at a time digitizing each pixel at 10 or 12 bits. The user can selectively output the most significant 8, 10 or 12 bits from each pixel with an impact to camera's frame rate. Frame time, or read-out time, is the time interval required for all the pixels to be read out of the image sensor. In non-triggered or fast trigger mode, while reading out the image from the storage registers within each pixel, the camera captures the next image. The exposure ends just as the readout of the previous frame ends and the next frame begins.

The Sony CMOS image sensor digitizes each pixel within a row simultaneously. This allows for more settling time, which lowers the overall noise floor and provides improved sensitivity. The low noise floor, combined with a reasonably large pixel charge capacity and extremely low dark current, translates into a large dynamic range of 71 dB (12-bits) or 12 F-stops.

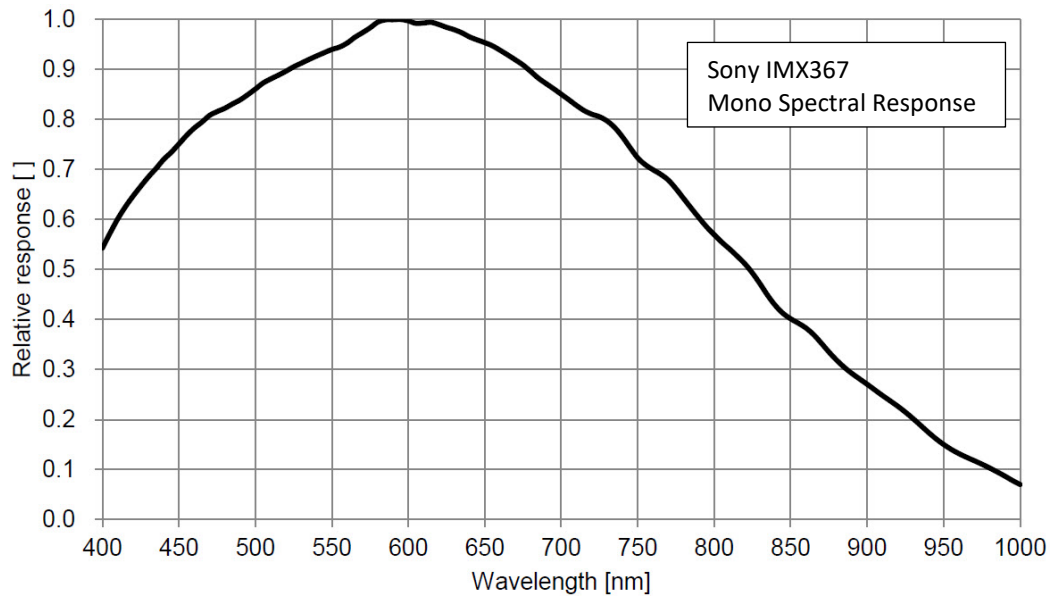
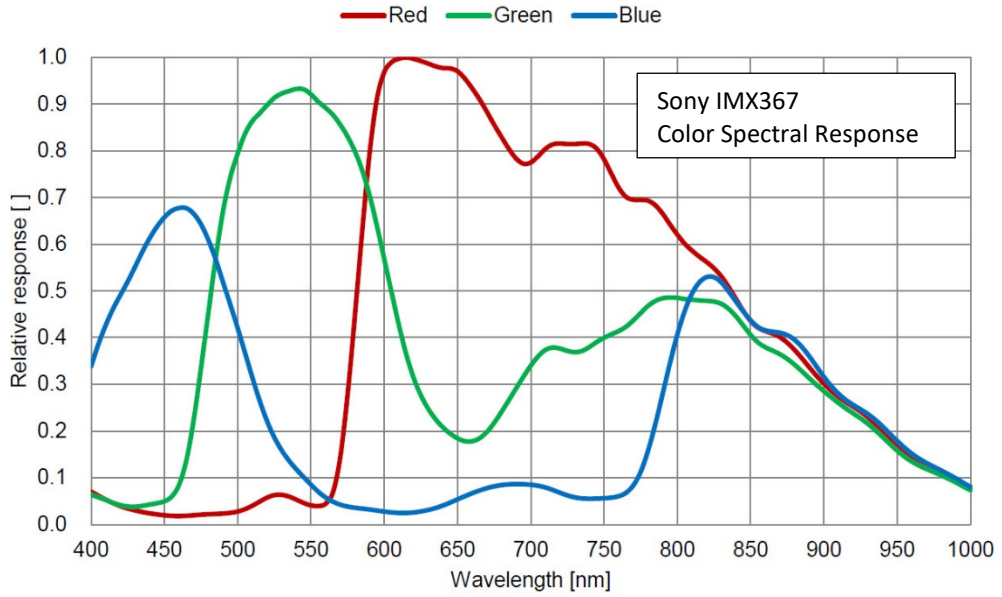
The sensor allows you to apply up to 48 dB of gain to the image. The first 24 dB of gain is analog gain and some improvement in noise performance may result. The camera applies the last 24 dB of gain digitally, which affects both signal and noise equally. Additional digital gain (up to 12 dB) can also be applied using the Digital Gain control.

Spectral Sensitivity

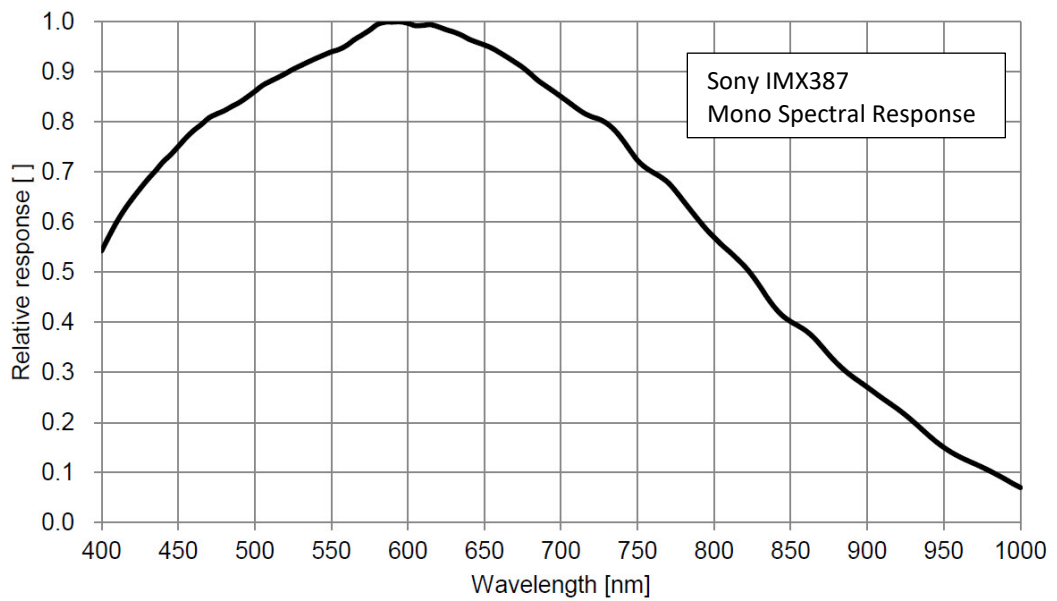
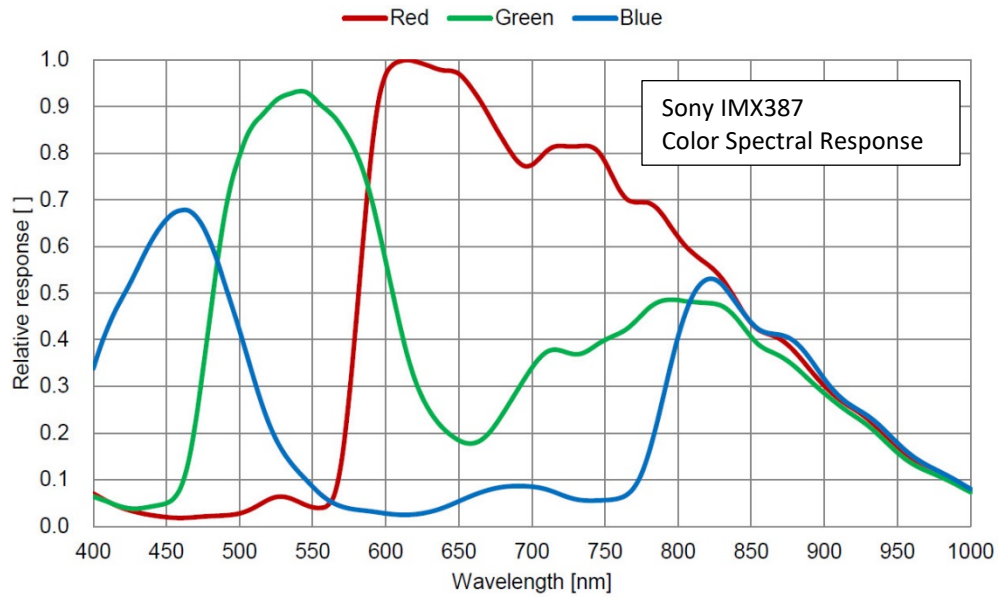
A set of color filters (red, green, and blue) arranged in a Bayer pattern over the pixels generates color images. The starting color is Red for SONY Pregius image sensors and follows the pattern: red, green, red, green, red, ... on row 1 and green, blue, green, blue, green, ... on row 2 and so on. The color and monochrome spectral responses of the sensors used in Cheetah cameras can be found in [Appendix A](#).

Appendix A: Spectral Response

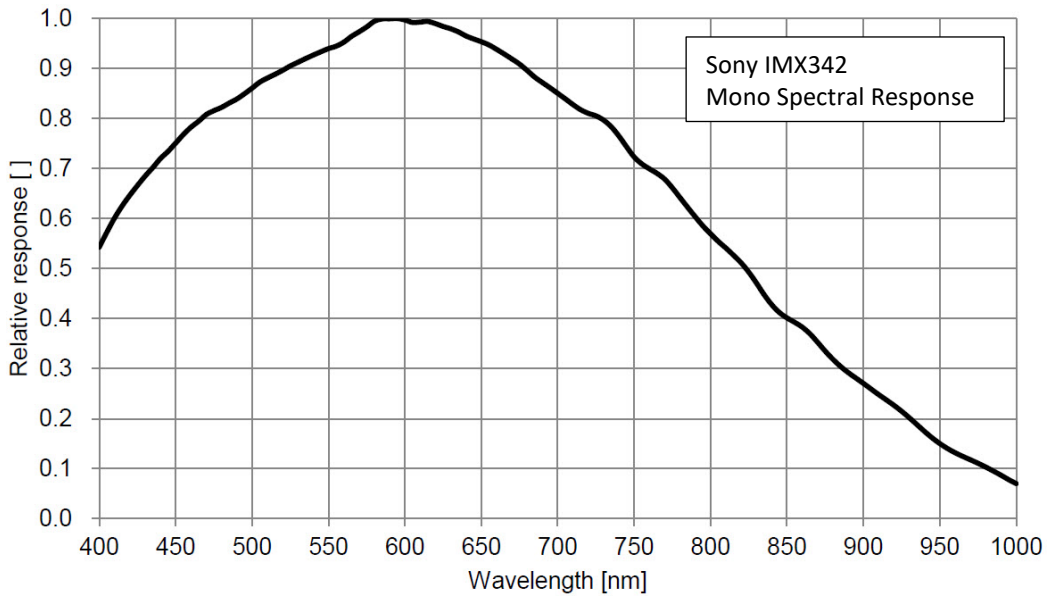
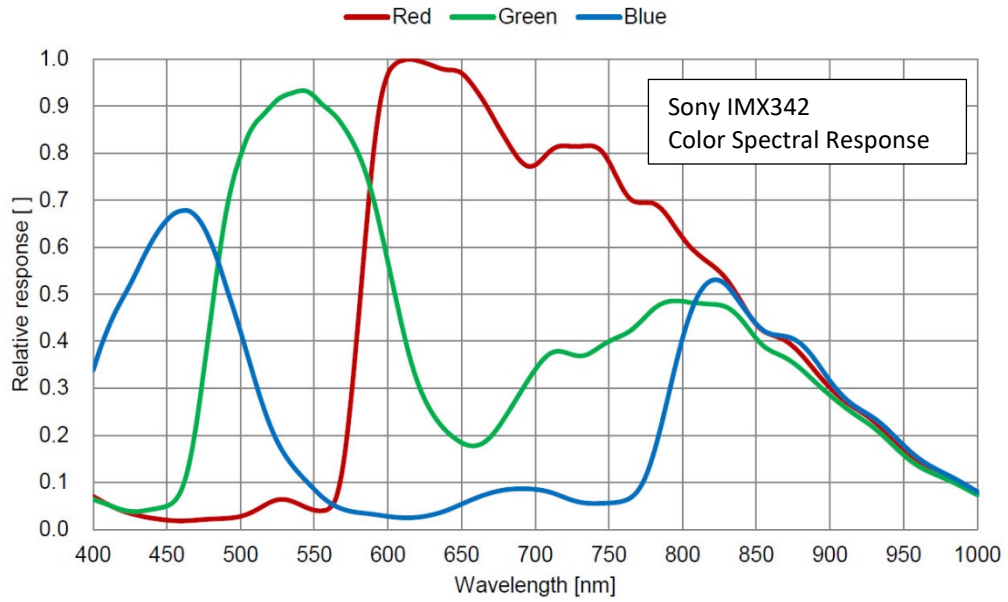
Cheetah C4440 Spectral Response



Cheetah C5440 Spectral Response



Cheetah C6440 Spectral Response



Appendix B: Creating Hot and Defective Pixel Correction Maps

Overview

Hot Pixel Correction and Defective Pixel Correction work with predetermined and preloaded Hot and Defective pixel maps.

Hot Pixel Map (HPM) and Defective Pixel Map (DPM) are uploaded into the camera's non-volatile memory.

You can edit the original (factory installed) HPM / DPM file and upload it into the camera to fit the unique requirements of your operating environment or camera use.

Editing HPM / DPM Files

You can edit HPM and DPM files in Microsoft Notepad or any other editing software. The file is a simple text file that looks like this:

```
-- Defective Pixel Map,  
-- Date: 05.18.2020,  
-- Model#: SFP-C6440M,  
-- Serial#: LAC001,  
:Table,  
-- Column (X) , Row (Y)  
    5683,155  
    3091,332  
    3532,893  
    650,1017  
    701,1017  
    1712,1053  
    914,1067
```

Pixel maps have two main sections: a header and a table. The header section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated with a comma. The table section of the file contains an array of lines with each line containing an X (column number) value followed by a comma and a Y (row number) value.

All pixels are listed in the HPM or DPM in order of increasing Y (row) location. If there are multiple hot or defective pixels in the same row (Y location is identical for both defective pixels), the listing is in order of increasing X (column) location.

The maximum number of pixels in the DPM list is 1024 and in HPM list is 4096.

To edit original DPM or HPM file, you need to identify defective or hot pixels, locate and adjust their coordinates, and accurately place pixels' coordinates into the pixel map.

Finding Defective Pixels

To see the defective pixels that are not in the factory DPM:

1. Make sure that the *DefectPixelCorrection* is set to Factory in the Data Correction menu of the software GUI.
The camera corrects the known pixel defects automatically.
2. Make sure that *TriggerMode* and *ExposureMode* are set to Off, and the camera resolution is set to maximum.
3. Capture an image with a uniform light source illuminating the sensor at about 50% ADU capacity (~2000 for 12-bit, ~500 for 10-bit, ~130 for 8-bit modes).
4. Identify any visible defective pixel and add them to the DPM as described in [Locating and adding pixel coordinates](#).

To see all the defective pixels, including those in the factory DPM:

1. Set *DefectPixelCorrection* to Off in the Data Correction menu.
2. Make sure that *BadPixelCorrection* is set to Factory.
3. Repeat steps 2–4 of the previous procedure.

TIP

To obtain the factory DPM file, contact Imperx technical support at:

Email: support@imperx.com

Toll Free: 1 (866) 849-1662 or (+1) 561-989-0006

Fax: (+1) 561-989-0045

Visit our website: www.imperx.com.

To create an HPM that contains all the hot pixels, see [Creating a DPM Using Imperx Toolkit](#).

To upload a new DPM into the camera, see [Uploading DPM / HPM Files](#).

Finding Hot Pixels

To see the hot pixels that are not in the factory HPM:

1. Make sure that *BadPixelCorrection* is set to Factory in the Data Correction menu.
The camera corrects the known hot pixels automatically.
2. Set the longest exposure time and slowest frame rate expected.
3. Put the lens cap on the camera.
4. Run the camera for at least 45 minutes at ambient temperature around 18–22 °C or higher.
5. Capture an image (or series of images).

6. Identify all visible hot pixels and add them to the HPM as described in [Locating and adding pixel coordinates](#).

To see all the hot pixels, including those in the factory HPM:

1. Set *BadPixelCorrection* to Off in Data Correction menu.
2. Make sure that *DefectPixelCorrection* is set to Factory.
3. Repeat steps 2–6 of the previous procedure.

TIP ⓘ

To obtain the factory HPM file, contact Imperx technical support at:

Email: techsupport@imperx.com

Toll Free: 1 (866) 849-1662 or (+1) 561-989-0006

Fax: (+1) 561-989-0045

Visit our website: www.imperx.com.

To create an HPM that contains all the hot pixels, see [Creating an HPM Using Imperx Toolkit](#).

To upload a new DPM to the camera, see [Uploading DPM / HPM Files](#).

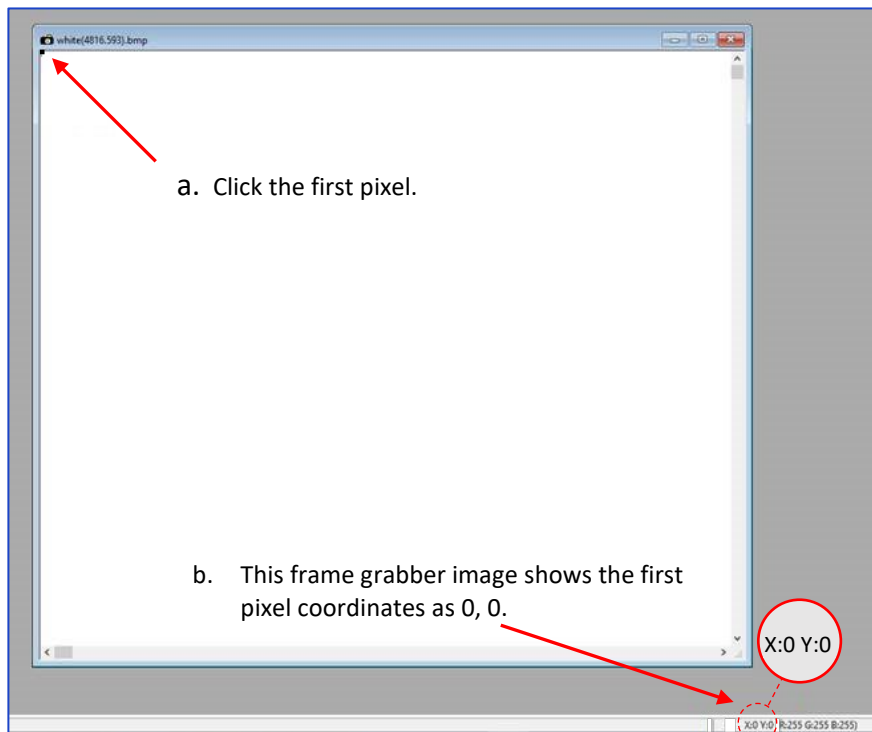
Locating and adding pixel coordinates

Follow the steps below to find first pixel coordinates, locate and adjust defective pixel coordinates, and accurately place defective pixel coordinates into the pixel map.

STEP 1: Find the First Pixel Coordinates

Your frame grabber's first pixel coordinates can affect the location accuracy of defective pixel coordinates. So, you must find the image sensor's first pixel coordinates and potentially adjust the defective pixel coordinates based on your findings.

Click the first pixel at the upper most left corner of the screen to find your frame grabber's first pixel X, Y coordinates.

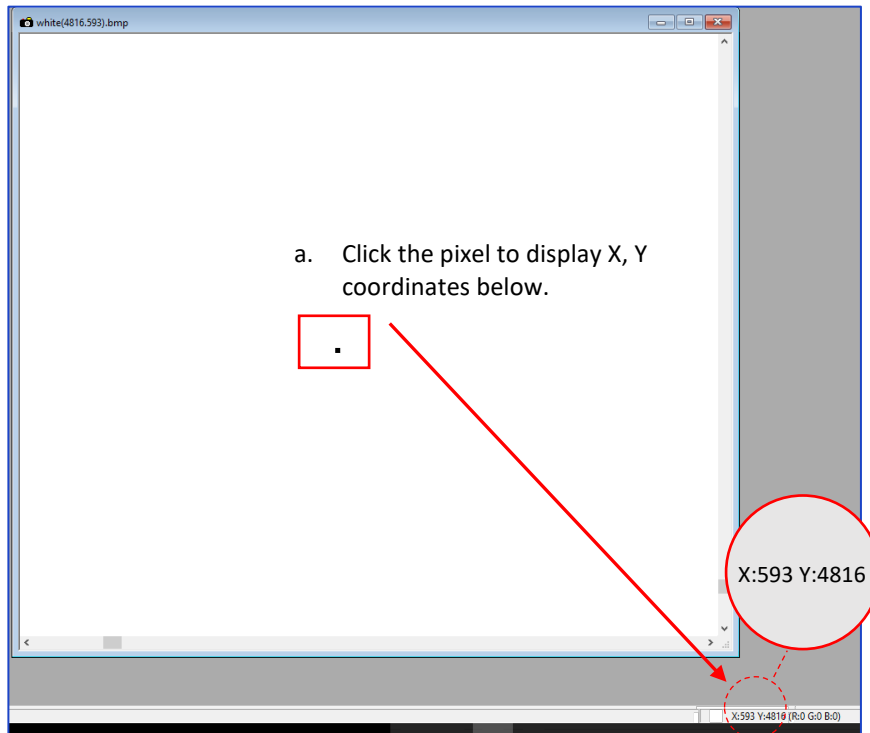


The coordinates will be either 0, 0 or 1, 1:

- If your frame grabber's first pixel coordinates are 0, 0, you should add 1 to both the X and Y coordinates of the defective pixel.
- If the first pixel coordinates are 1, 1, do not add 1 to either coordinate.

STEP 2: Find Defective Pixel Coordinates

Click the defective pixel to find its X, Y coordinates.



The coordinates are 593, 4816, where X (Column) = 593 and Y (Row) = 4816.

IMPORTANT: Frame grabbers from different manufacturers may display pixel location coordinates in different order, for example:

X (Column), Y (Row) or,
X (Row), Y (Column).

You must put defective pixel coordinates into the pixel correction map file in this order:
X (Column), Y (Row).

If your frame grabber identifies pixel coordinates by X (**Row**), Y (**Column**), you must transpose the coordinates to X (**Column**), Y (**Row**) before entering them into the pixel map files. For example, if the 593, 4816 coordinates in the screen above had been displayed in this order, where X:593 is a row and Y:4816 is a column, you would have had to transpose the coordinates to 4816, 593.

STEP 3: Adjust Defective Pixel Coordinates

As described in **STEP 1**, if the first pixel coordinates are 0, 0, you must adjust the defective pixel coordinates by adding 1 to both coordinates as shown in the following:

$$593 (+1), 4816 (+1) = 594, 4817$$

- If the frame grabber pixel coordinates are Column (X), Row (Y), then go to **STEP 4**.
- If the frame grabber pixel coordinates are Row (X), Column (Y), then transpose the coordinates to the form Column, Row and then go to **STEP 4**.

STEP 4: Add Defective Pixel Coordinates to Defective Pixel Map

Place the defective pixel coordinates in the Defective Pixel Map file in ascending (increasing) numerical order of the Y (row) coordinate. The value of all Y coordinates should progressively increase as you look down the list of X, Y coordinates.

Example 1: Different Y coordinates	Example 2: Identical Y coordinates
<pre> -- Defective Pixel Map, -- Date: 5.18.2020, -- Model#: SFP-C6440M-RF, -- Serial#: LAC001, :Table, -- Column (X) , Row (Y) 701, 1017 100, 1018 4325, 1019 2241, 1020 458, 1021 1712, 1053 914, 1067 3954, 1546 2516, 1670 3451, 3331 1111, 4149 95, 4364 594, 4817 433, 4828 </pre> <p style="border: 1px solid red; padding: 2px; display: inline-block;">Row coordinates are in ascending order (increasing Y values).</p>	<pre> -- Defective Pixel Map, -- Date: 5.18.2020, -- Model#: SFP-C6440M-RF, -- Serial#: LAC001, :Table, -- Column (X) , Row (Y) 650, 1017 698, 1017 701, 1017 100, 1018 4325, 1019 2241, 1020 458, 1021 1712, 1053 f914, 1067 3954, 1546 2516, 1670 3451, 3331 1111, 4149 95, 4364 433, 4828 </pre> <p style="border: 1px solid red; padding: 2px; display: inline-block;">Column coordinates are in ascending order (increasing X values).</p>

As shown in the **Example 1** above, the Y coordinate of **594, 4817** is higher than **4364** and lower than **4828**. Do not add defective pixel coordinates at the end of the list unless the Y coordinate is the highest of all Y values.

NOTE ⚠ If adding a defective pixel with a Y location identical to one or more other defective pixels, insert its coordinates based on the order of increasing X location.

As shown in the **Example 2** above, the Y coordinate of **698, 1017** is identical to two other defective pixels. Place its coordinates between **650, 1017** and **701, 1017** because its X location (698) is higher than 650 but lower than 701.

STEP 5: Save your DPM/HPM

- Save your Defective Pixel Map with the file extension .dpm.
- Save your Hot Pixel Map with file extension .hpm.

Creating a DPM/HPM Using a Text Editor

You can create your own DPM and HPM files using any ASCII text editor, such as Notepad or similar. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, the file must be renamed to include the .dpm or .hpm file extension. The files look like this:

```
-- Defective Pixel Map,
-- Date: 5.18.2020,
-- Model#: SFP-C6440M,
-- Serial#: LAC001,
:Table,
-- Column (X) , Row (Y)
    5683,155
    3091,332
    3532,893
    650,1017
    701,1017
    1712,1053
    914,1067
```

Pixel maps have two main sections: a header and a table. The header section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated with a comma. The table section of the file contains an array of lines with each line containing an X (column number) value followed by a comma and a Y (row number) value.

All pixels are listed in the DPM or HPM in order of increasing Y (row) location. If the Y location is identical, the listing is in order of increasing X (column) location.

The maximum number of pixels in the DMP list is 1024 and in HPM list is 4096.

To create a DPM or HPM file:

1. Identify defective or hot pixels (refer to the sections [Finding Defective Pixels](#) and [Finding Hot Pixels](#)).

IMPORTANT: When creating a new pixel map, you need to get all defective pixel visible. Make sure that the *DefectivePixelCorrection* and *BadPixelCorrection* are set to Off in the Data Correction menu of the software GUI, so the camera does not correct the known pixel defects.

2. Locate and adjust defective pixels' coordinates (refer to the section [Locating and adding pixel coordinates](#), **STEP1 – STEP3**).
3. Place pixels' coordinates into the pixel map and save the file (refer to the section [Locating and adding pixel coordinates](#) **STEP4, STEP5**).

EXAMPLE

In this example, the first table entry is pixel 4 from row 1, the next entry is pixel 588 from row 1, and the next entry is pixel 78 from row 5, and so on. The file looks like this:

```
:Table,
-- Column (X) , Row (Y)
    4,1
    588,1
    78,5
    82,27
    405,300
```

Creating a DPM Using Imperx Toolkit

1. Set *DefectPixelCorrection* to Off in the Data Correction menu.
2. Make sure that *BadPixelCorrection* is set to Factory.
3. Make sure that *TriggerMode* and *ExposureMode* are set to Off, and the camera resolution is set to maximum.
4. Capture an image (or series of images) with a uniform light source illuminating the sensor at about 50% ADU capacity (~2000 for 12-bit, ~500 for 10-bit, ~130 for 8-bit modes) and Save the image(s) in RAW format.
5. In the IpxToolkit main window, navigate to the saved RAW file(s) and open it.
6. On the **Image Properties** tab:
 - Set **Setup Mode** to Manual.
 - Set **Device Type** GigE Vision.
 - Set **Width** and **Height** to the RAW image's vertical and horizontal size respectively.
 - Set Pixel Type to the Pixel Format of the RAW image.
The options are Mono8, Mono10, or Mono12 for a monochrome camera and RGB8, RGB10, or RGB12 for a color camera.
 - Click **Apply**.
7. Select **Tools > DPM/HPM Utility**.
8. On the **Dark & Bright** tab, navigate to the saved RAW file(s) and open it.
9. Move the **Dark** slider to the value that you want to be the maximum luminosity for the dark pixels.
The pixels are treated as dark if their luminosity is lower than the Dark limit.
10. Move the **Bright** slider to the value that you want to be the minimum luminosity for the bright pixels.
The pixels are treated as bright if their luminosity is higher than the Bright limit.
11. Click **Start**.
The dark and bright pixels are added to the **List of Defected Pixels** table.
The maximum number of pixels in the DMP is 1024.
12. Fill out the **Camera** and **Serial#** fields and click **Save to File**.

Creating an HPM Using Imperx Toolkit

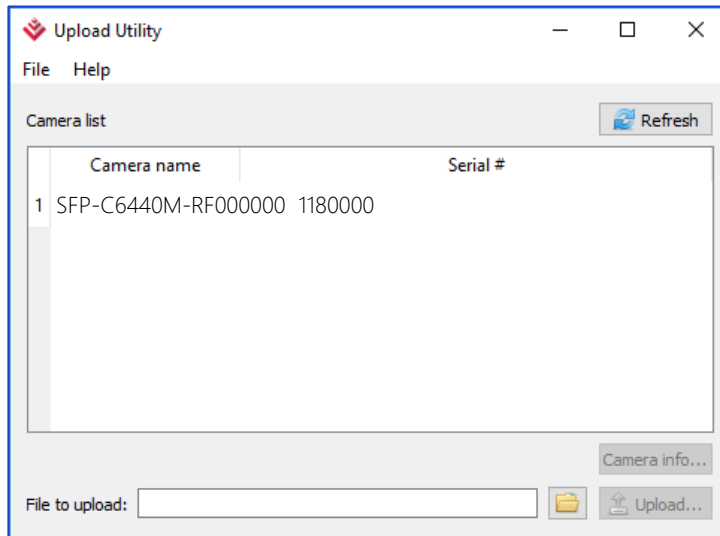
1. Set *BadPixelCorrection* to Off in the Data Correction menu.
2. Make sure that *DefectivePixelCorrection* is set to Factory.
3. Set the longest exposure time and slowest frame rate expected.
4. Cover a lens with a lens cap or dismount the lens and put on a dust cap on the.
5. Run the camera for at least 45 minutes at ambient temperature around 18–22 °C or higher.
6. Capture an image (or series of images) and save it in RAW format.
7. In the IpxToolkit main window, navigate to the saved RAW file(s) and open it.
8. On the **Image Properties** tab:
 - Set **Setup Mode** to Manual.
 - Set **Device Type** to GigE Vision.
 - Set **Width** and **Height** to the RAW image's vertical and horizontal size respectively.
 - Set **Pixel Type** to the Pixel Format of the RAW image.
The options are Mono8, Mono10, or Mono12 for a monochrome camera and RGB8, RGB10, or RGB12 for a color camera.
 - Click **Apply**.
9. Select **Tools > DPM/HPM Utility**.
10. On the **Hot** tab, navigate to the saved RAW file(s) and open it.
11. Move the **Threshold** slider to the value that you want to be the minimum luminosity for the hot pixels.
The pixels are treated as hot if their luminosity is higher than the Threshold limit.
12. Click **Start**.
The dark and bright pixels are added to the **List of Defected Pixels** table.
The maximum number of pixels in HPM is 4096.
13. Fill out the **Camera** and **Serial#** fields and click **Save to File**.

Uploading DPM / HPM Files

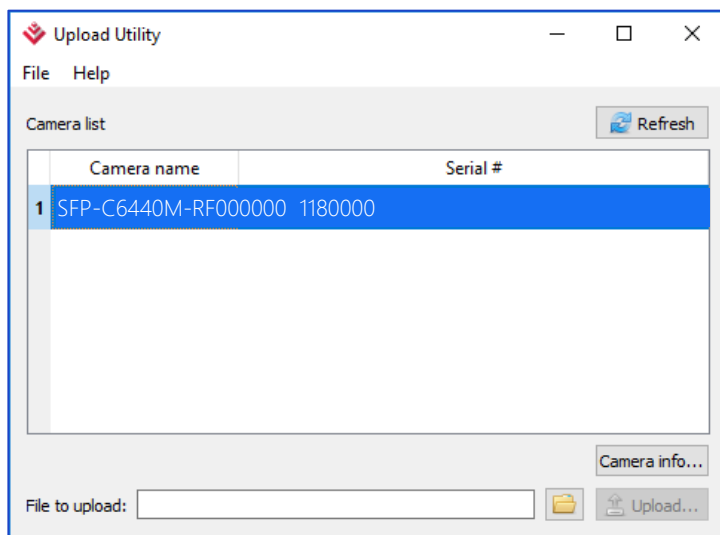
After saving the maps, you can upload them to the camera using the Imperx **Upload Utility**. The Upload Utility enables uploads of DPM, HPM, and other files to your camera.

To upload DPM and HPM files:

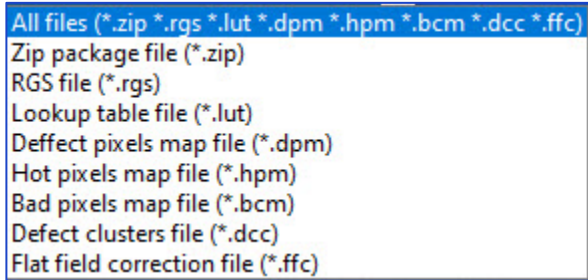
1. Connect and power up your camera.
2. Start the Imperx **Upload Utility** and wait for the Utility to detect the camera. If the utility does not detect the camera, click **Refresh** to restart the device collection.



3. Select the camera to update if more than one appears.



4. Browse for either the edited .dpm file or .hpm file, select it, and click **Upload**.
Wait for the upload to finish.



5. After the upload is completed, do a power cycle on the camera.
6. After the camera re-starts, start your software GUI and select **Data Correction**.
7. Make sure that *DefectivePixelCorrection* and *BadPixelCorrection* are set to **User** so that the camera uses the maps you loaded.
8. Retake images as described in sections [Finding Defective Pixels](#) and [Finding Hot Pixels](#) to make sure that all defective and hot pixels are now corrected.

Appendix C: Look Up Tables

Creating an LUT Using a Text Editor

You can use any ASCII text editor, such as Notepad or similar, to create a custom LUT. Alternatively, any spreadsheet program (i.e. Microsoft Excel) can be used by converting the spreadsheet into a comma delimited (.csv) file. In either case, rename the file to include the .lut file extension.

The .lut file has two main sections: a header and a table. The header section is a free text area of up to 256 ASCII characters. Each line of the header section must be terminated in a comma. The table section of the file contains an array of 4096 lines with each line containing an input value followed by a comma and an output value. The input values represent incoming pixels and the output values represent what each incoming pixel should be converted into as an output pixel.

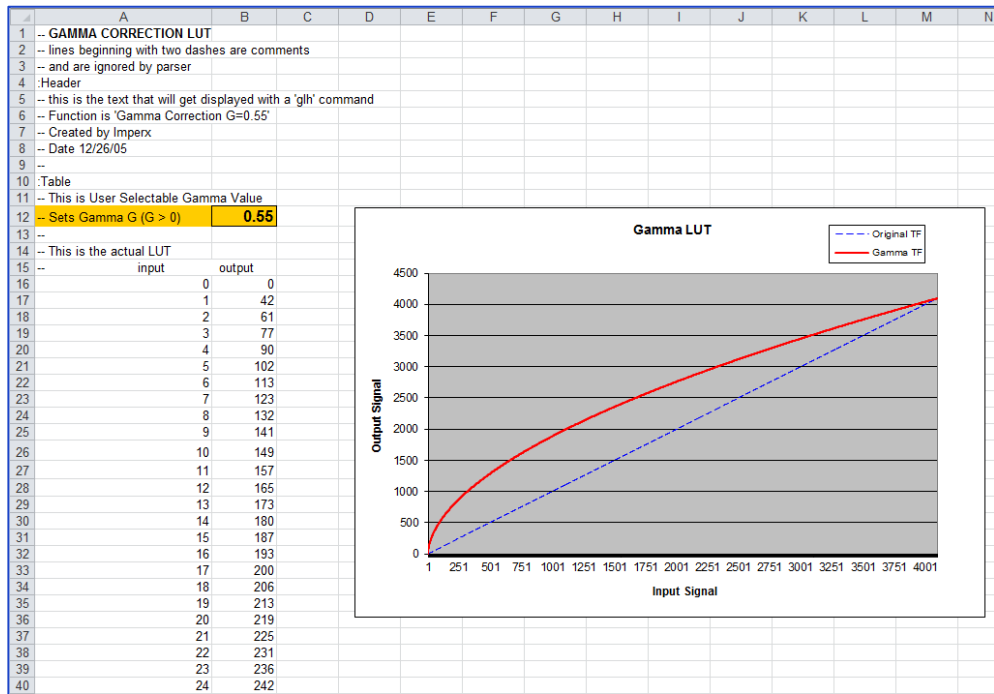
The format of the .lut file is as follows:

```
-- Look Up Table input file example,  
-- lines beginning with two dashes are comments,  
-- and are ignored by parser,  
:Header,  
-- this is the text that will get displayed with a 'glh' command,  
Function is 'Negative Image',  
Created by John Doe,  
Date 1/14/20,  
:Table,  
-- input output,  
    0,4095  
    1,4094  
    2,4093  
    3,4092  
    4,4091  
    :  
4095,0
```

Creating an LUT Using Microsoft Excel

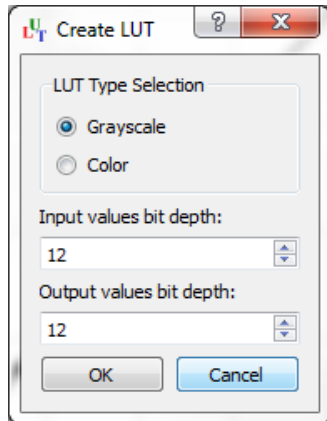
The LUT file can be created in Excel as follows:

1. Create the spreadsheet as shown below (note that 4096 rows are required in the table).
2. Add the necessary equations into the output cells to generate the transfer function required.
3. Save the file as a .csv (comma delimited format).
4. Rename the .csv file to an extension of .lut.



Creating an LUT Using Imperx Toolkit

1. On the Tools tab, open LUT Manager utility.
2. Create a new LUT file. On the Create LUT dialog box, select the LUT type, set the input and output bit depth to 12, and click **OK**.



3. Click **Customize** under the LUT plot.
4. Click **More**, set **Curve type** to Dots and **Formula** to User.
5. Type in a formula for the new LUT (see below).
The following operands and operations are available:

Operation	Description
+	Addition
-	Substraction
*	Multiplication
/	Division
^	Raise to the power of
cos()	Cosine function
sin()	Sine function
tan()	Tangent function
acos()	Arc-Cosine function
asin()	Arc-Sine function
atan()	Arc-Tangent function
sqrt()	Square root
ln()	Log natural
exp()	Exponent

Operator	Description
x	x-value
pi	Mathematical constant approximately 3.1415926535897932

6. For a color camera, you can set a transfer function for each channel. Use R, G, and B tabs on the left to switch between the channels.
7. To save the LUT file, go to **File > Save as....**

Example

A modified sigmoid function can be used to enhance low contrast images. The modified sigmoid function is given below:

$$F(x) = \frac{1}{1 + e^{-a(x-b)}}$$

where **x** is the input pixel value.

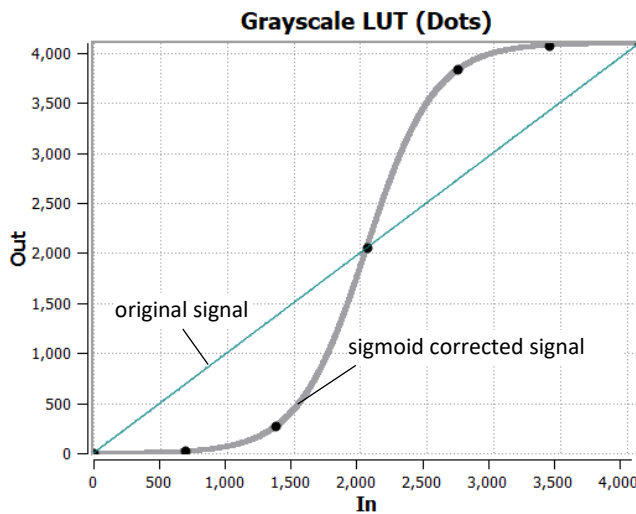
a is a contrast factor. It determines the steepness of the curve (0.5 – low gain; 10 -high gain).

b is a threshold level. It determines a sigmoid’s midpoint. A midpoint is the brightness of input pixels that is used as a reference. If the brightness of an input pixel is higher than a midpoint, the output pixel value is increased. Otherwise, the output pixel value is decreased.

In the LUT Manager window, type in the following formula under the *Formula* control (with a=4 and b=2):

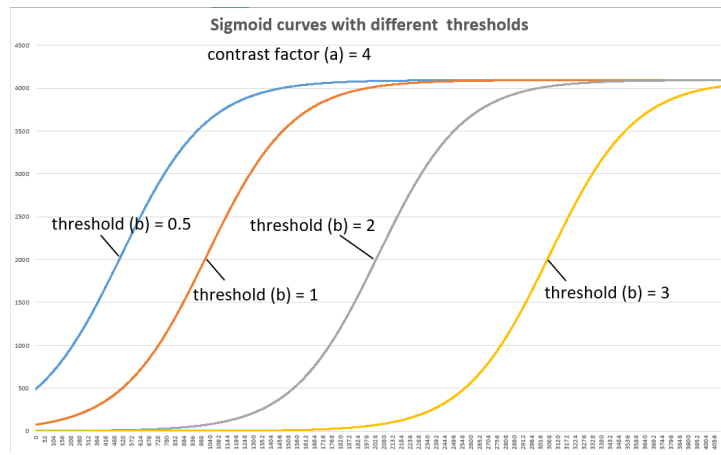
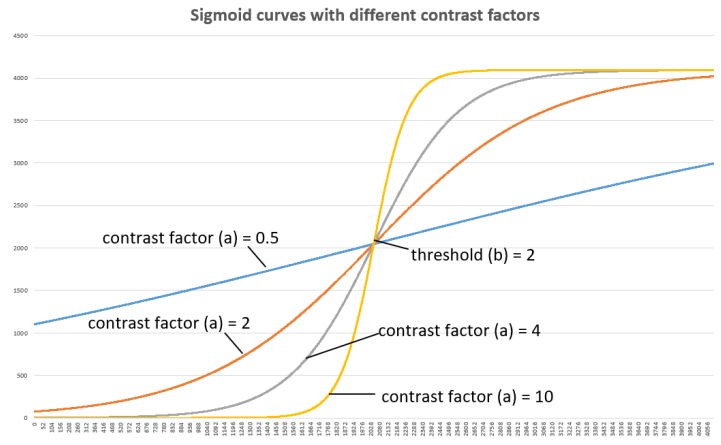
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4095*(1/(1+(exp(-4*(x/(4095/4)-2))))))
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The function is scaled so that the input and output pixel values are within the range from 0 to 4095 (for a 12-bit image).



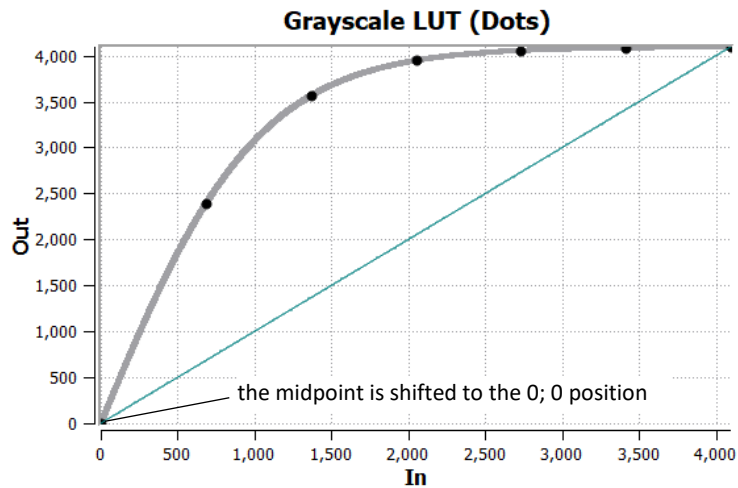
To adjust the overall brightness and contrast of the image, use both threshold and contrast factor parameters. The threshold value controls the amount of brightness, and the contrast factor controls the difference between pixels.

The sigmoid curves with varied threshold and contrast factor parameters are shown below:



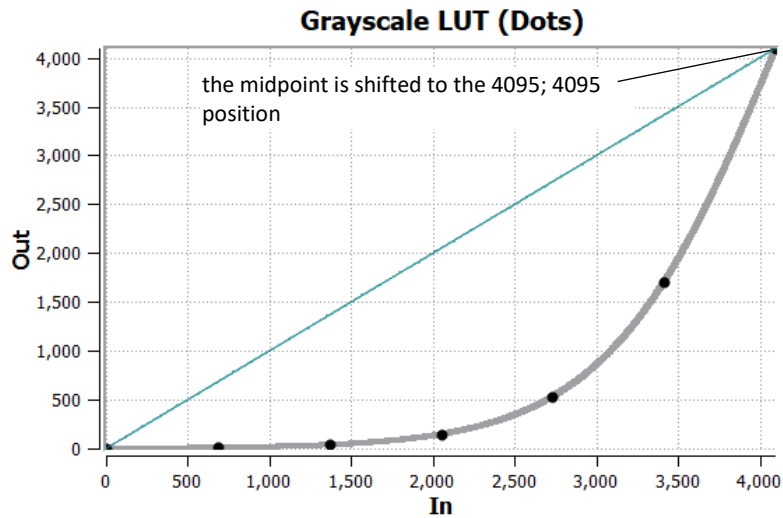
To apply a convex part of the curve within the range from 0 to 4095, use the following formula:

$$2 * 4095 * (1 / (1 + (\exp(-2 * (x / (4095 / 4)))))) - 0.5$$



To apply a concave part of the curve within the range from 0 to 4095, use the following formula:

$$2*4095*(1/(1+(\exp(-2*(x/(4095/4)-4))))))$$

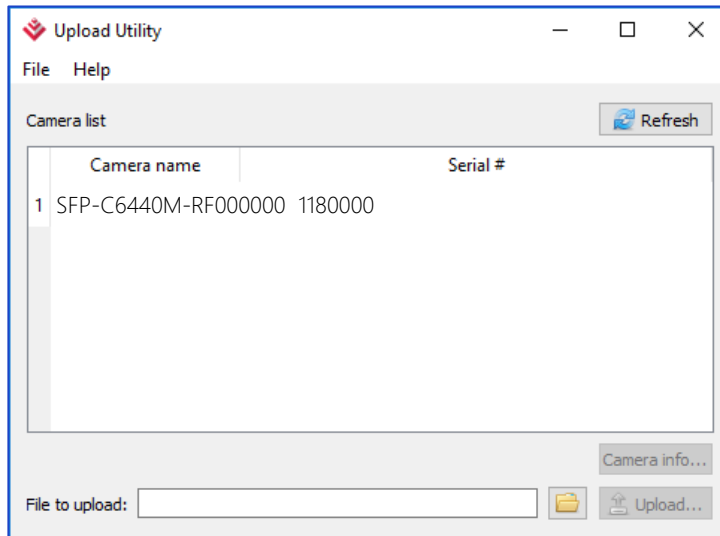


Uploading the LUT File

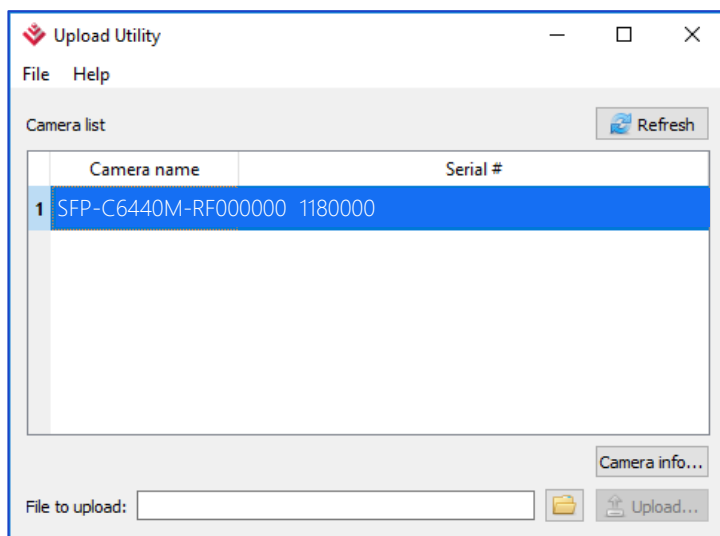
After saving the LUT into the .lut file, you can upload it into the camera using the Imperx **Upload Utility**.

To upload the LUT file:

1. Connect and power up your camera.
2. Start the Imperx **Upload Utility** and wait for the Utility to detect the camera. If the utility does not detect the camera, click **Refresh** to restart the device collection.



Select the camera to update if more than one appears.



3. Browse for the .lut file, select it, and click **Upload**.
Select to which camera's LUT (LUT1–LUT4) to upload the .lut file you created.
Wait for the upload to finish.
4. After the upload is completed, do power cycle the camera.
5. After the camera re-starts, start the software GUI and select **Data Correction**.
6. Set *LUTEnable* to the LUT you uploaded.
The camera then uses the LUT you uploaded.